SKYWARN Basic Storm Spotter Training

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National Weather Service (NWS) – Calera, AL

Spotter Training Agenda

Part I

- Who we are, and why we need spotters?
- Severe weather definitions
- What and how to report
- Safety in storm spotting

--Break--

Part II

- Thunderstorm development and thunderstorm types
- Mesocyclone
- Wall Clouds vs. Shelf Clouds; Scud Clouds and Tail Clouds
- Tornado formation
- Report what you see; photo polls
- Spotter information recap

Disclaimer

This is not storm chaser training!

The National Weather Service encourages everyone, at all times, to seek shelter when threatened by hazardous weather!

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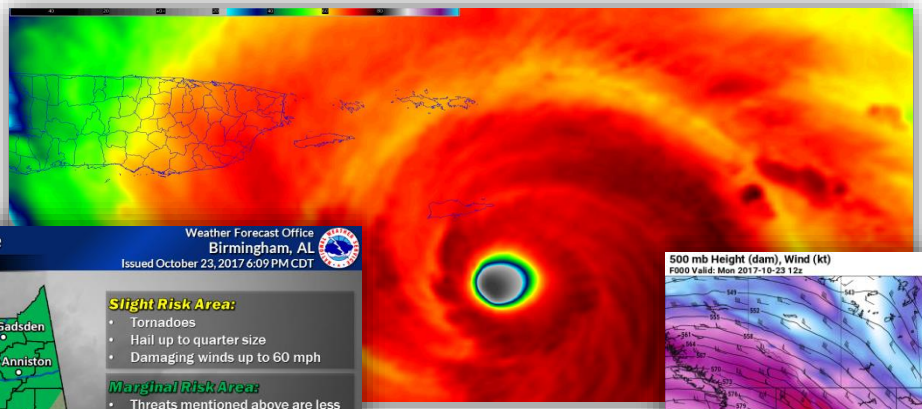
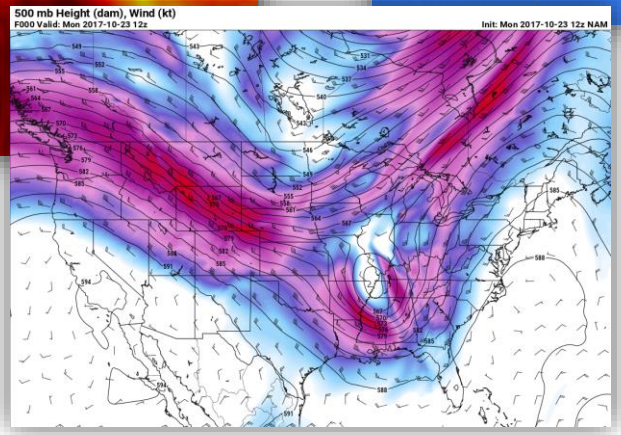
Who is the National Weather Service?

- A team of forecasters, electronic and computer technicians
- We constantly evaluate the atmosphere, gather and disseminate data
- Issue forecasts; watches, warnings, and advisories
- We work with media to communicate weather information to you
- We work with emergency managers to help communities prepare and respond to severe weather

Why Are We Here?





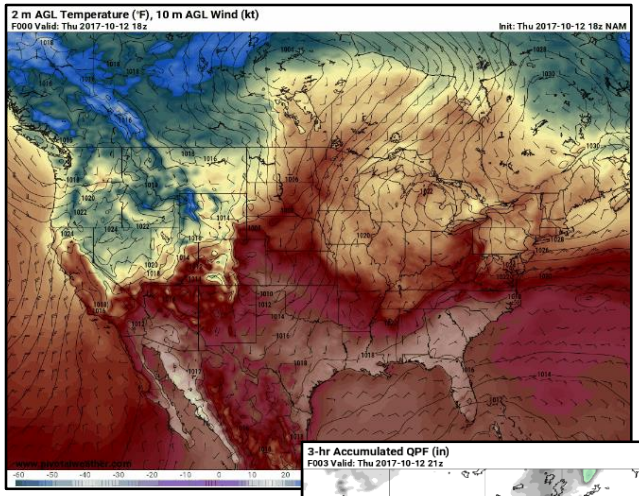
Protect Life and Property

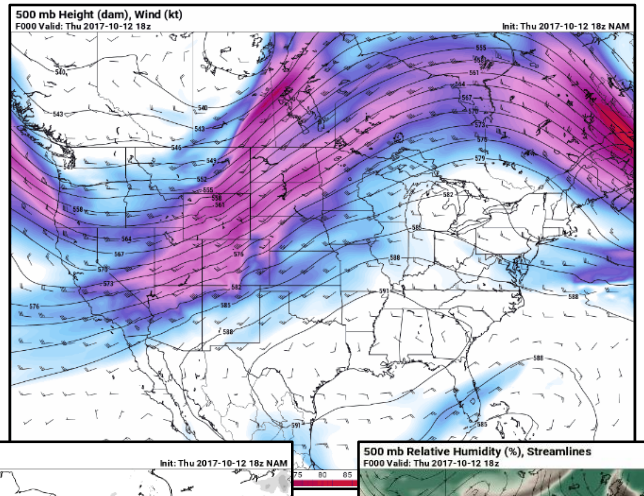
Help you make informed decisions

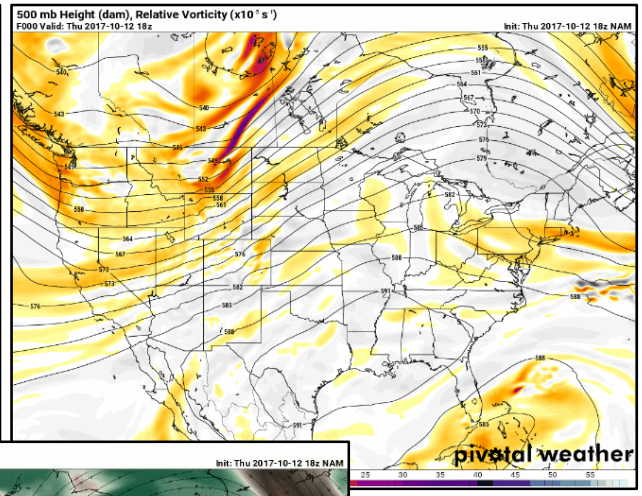
Building a Weather-Ready Nation

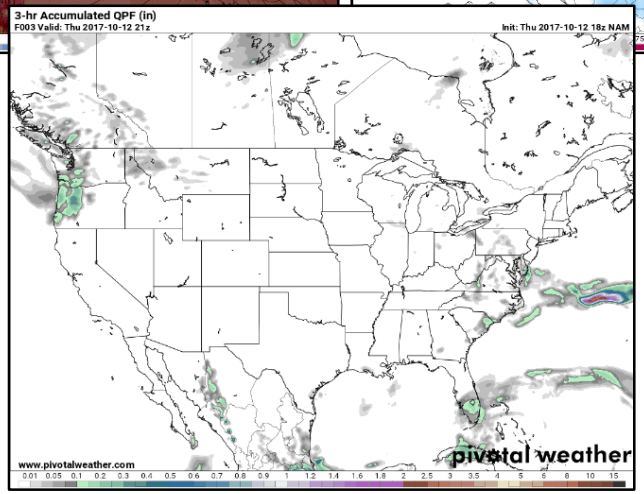
How do We Look at the Weather?

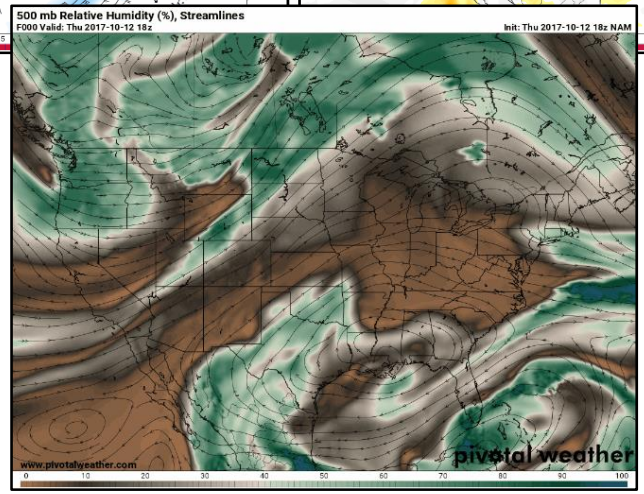
COMPUTER MODELS





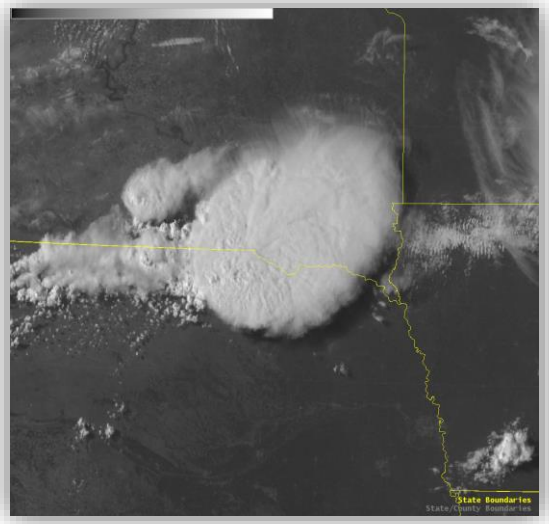


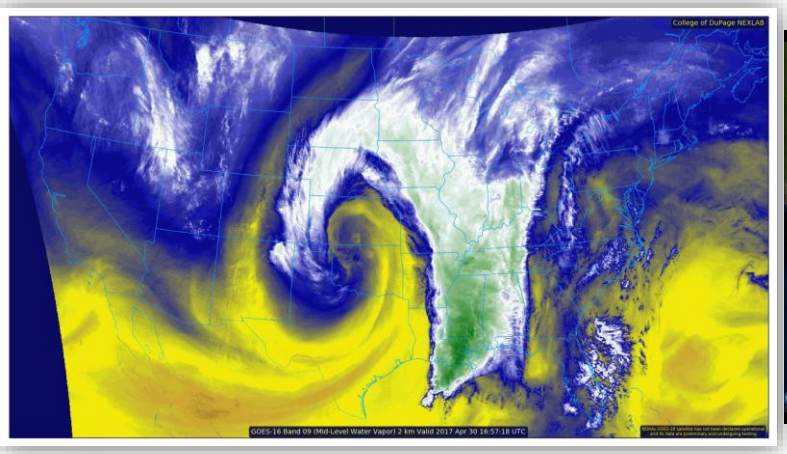


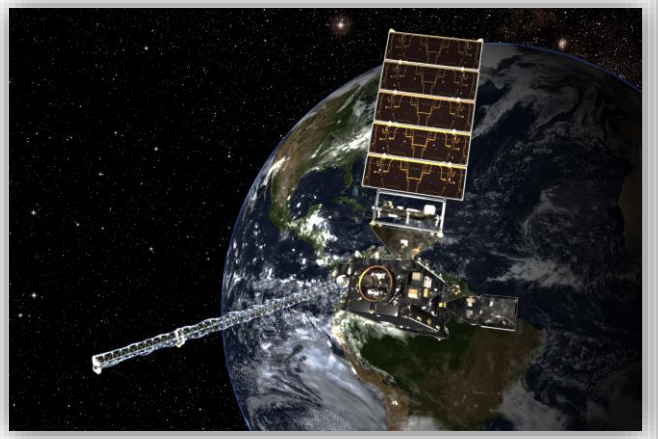


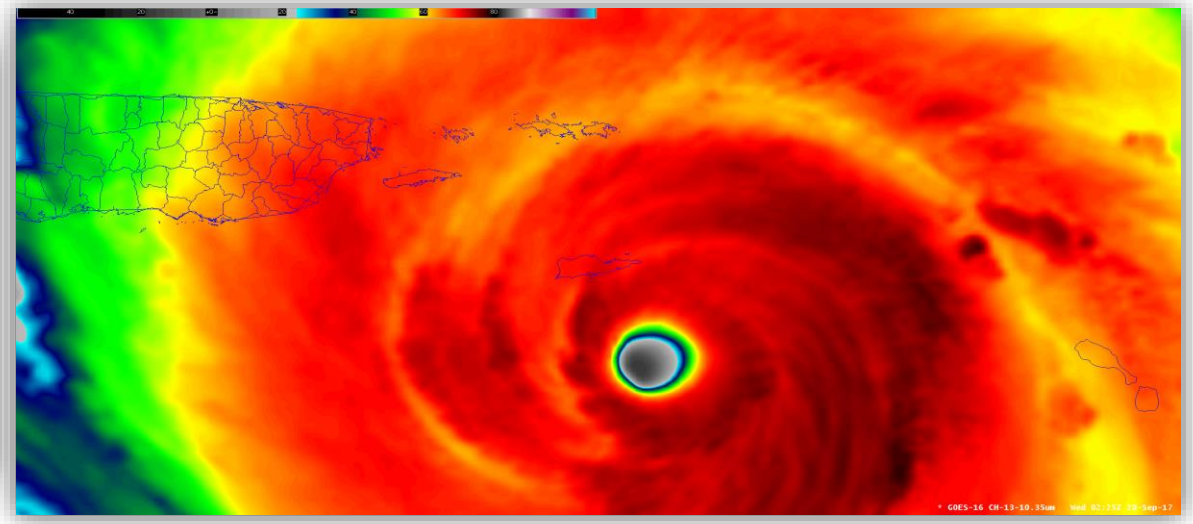
How do We Look at the Weather?

SATELLITE



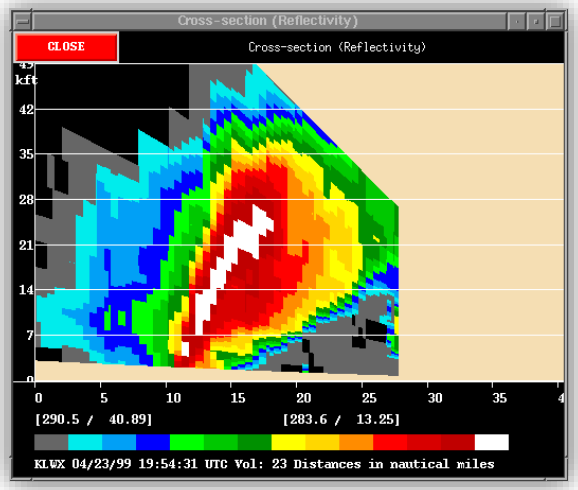


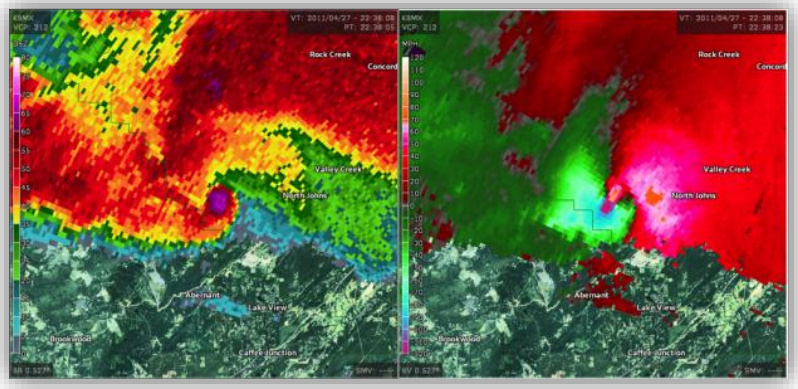


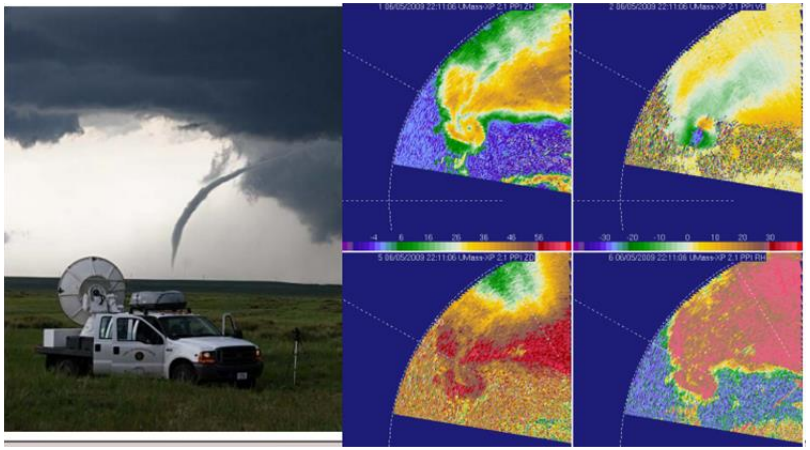


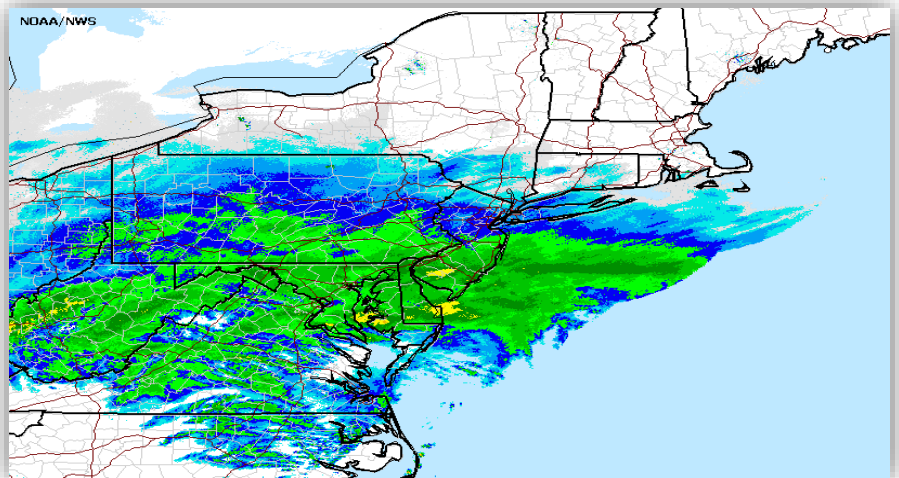
How do We Look at the Weather?

RADAR







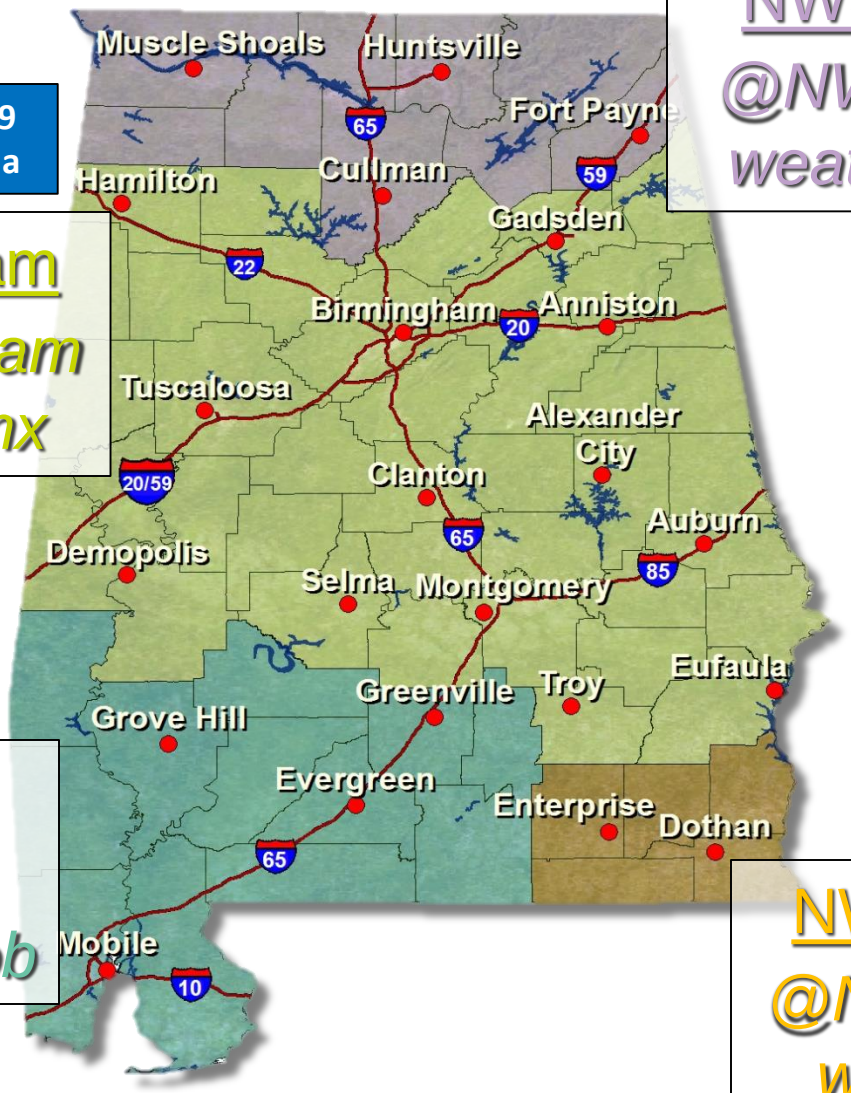


How do We Observe the Weather?

WEATHER STATIONS, INSTRUMENTS

Alabama NWS Offices

NWS Birmingham Serves 39 Counties in Central Alabama



NWS Huntsville
@NWSHuntsville
weather.gov/hun

NWS Birmingham
@NWSBirmingham
weather.gov/bmx

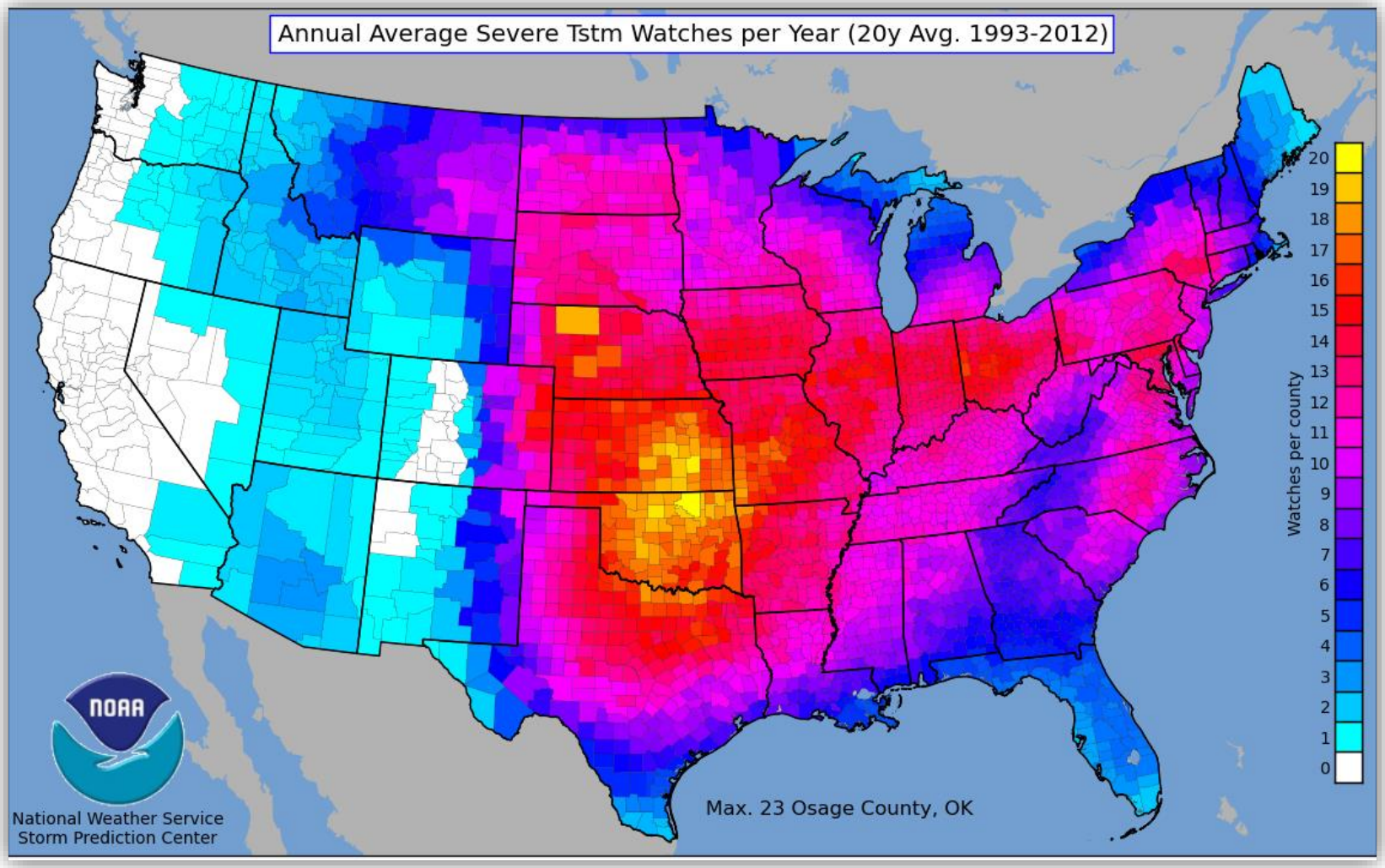
NWS Mobile
@NWSMobile
weather.gov/mob

NWS Tallahassee
@NWSTallahassee
weather.gov/tae

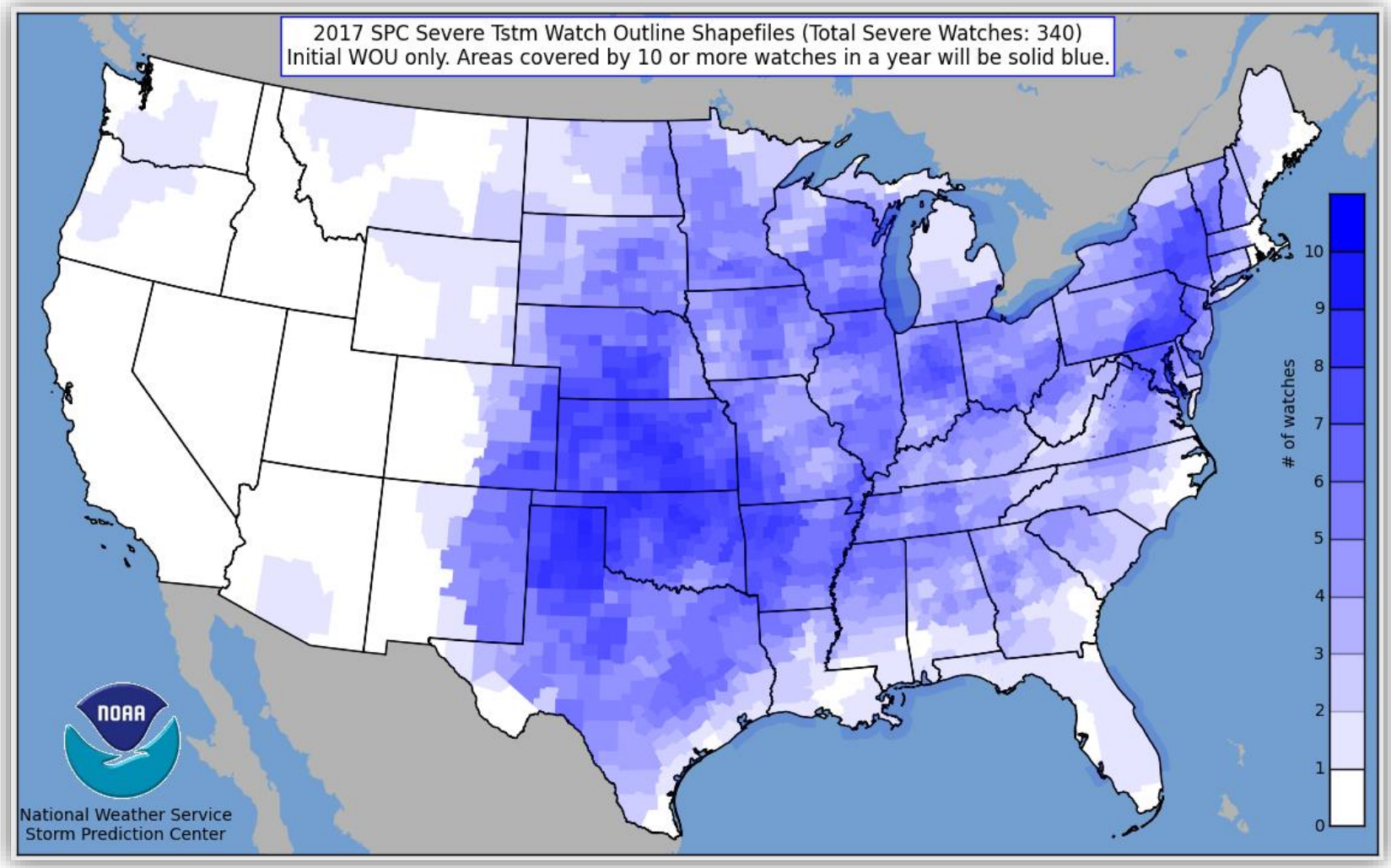
Why We Need Spotters (you)?

- **Ground truth!**
  - **Real-time verification**
  - **Reports add credibility and increase public response**

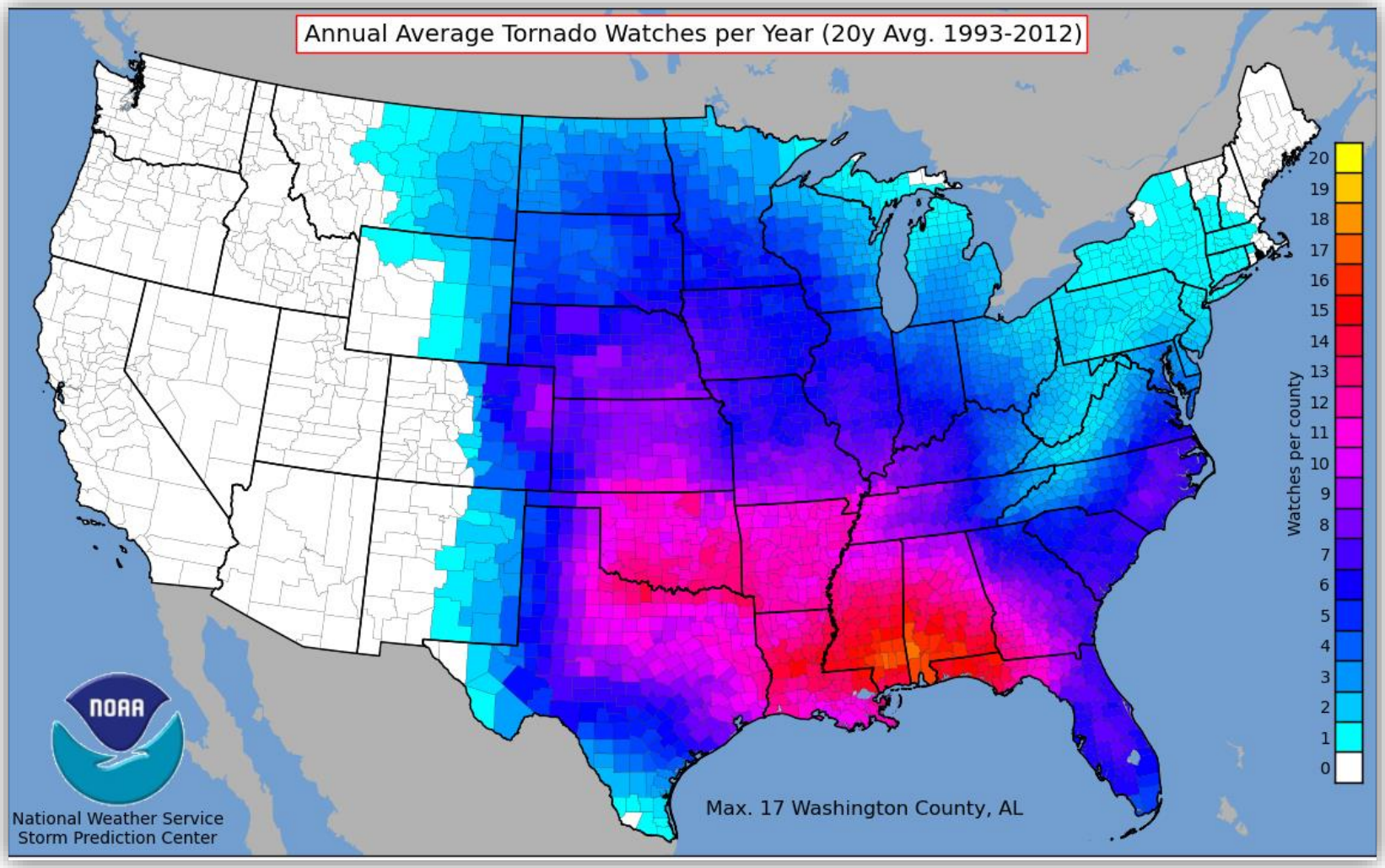
20-Year SPC Watch Climatology
Severe Thunderstorm



To-date 2017 SPC Watches
Severe Thunderstorm



20-Year SPC Watch Climatology
Tornado



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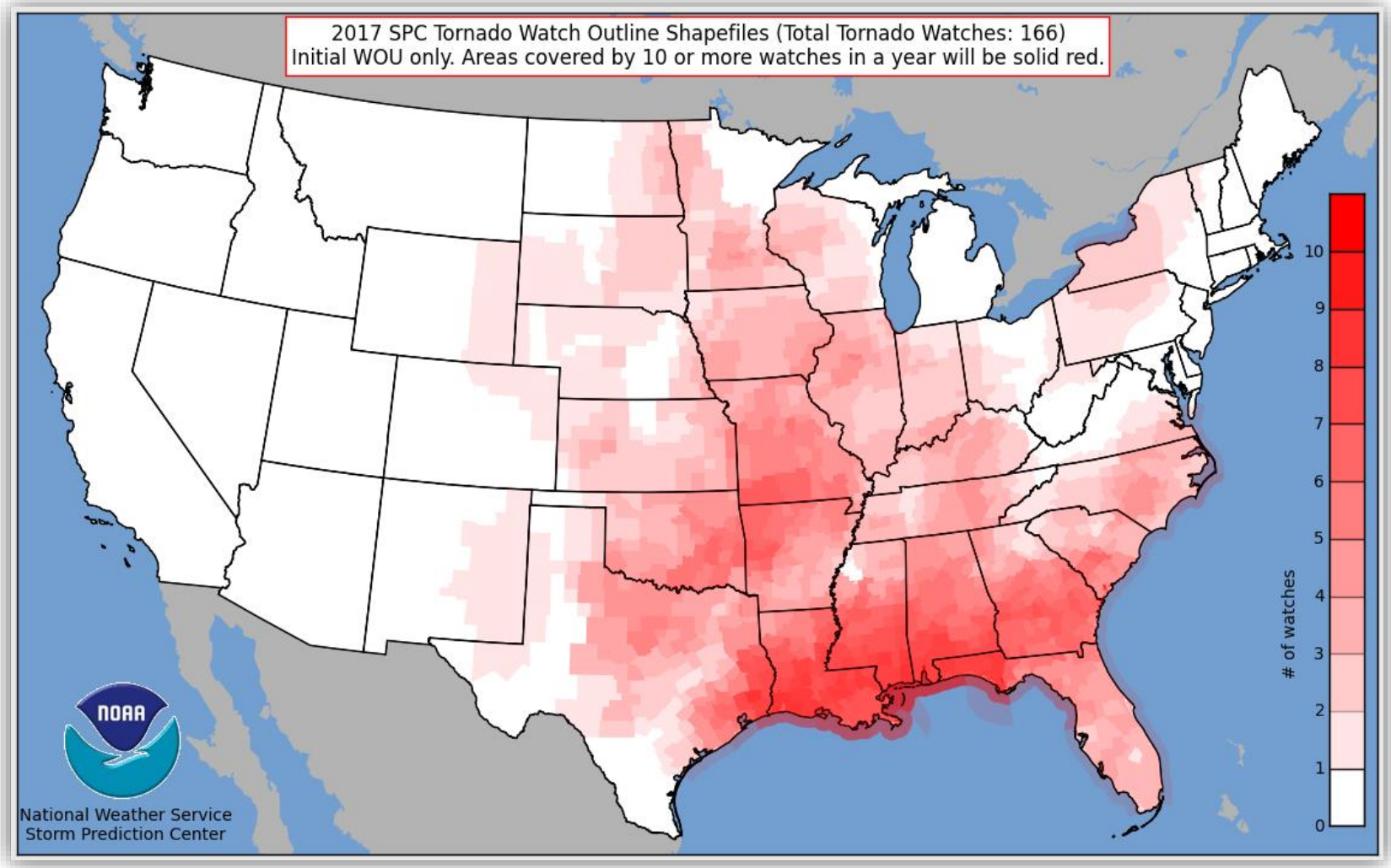
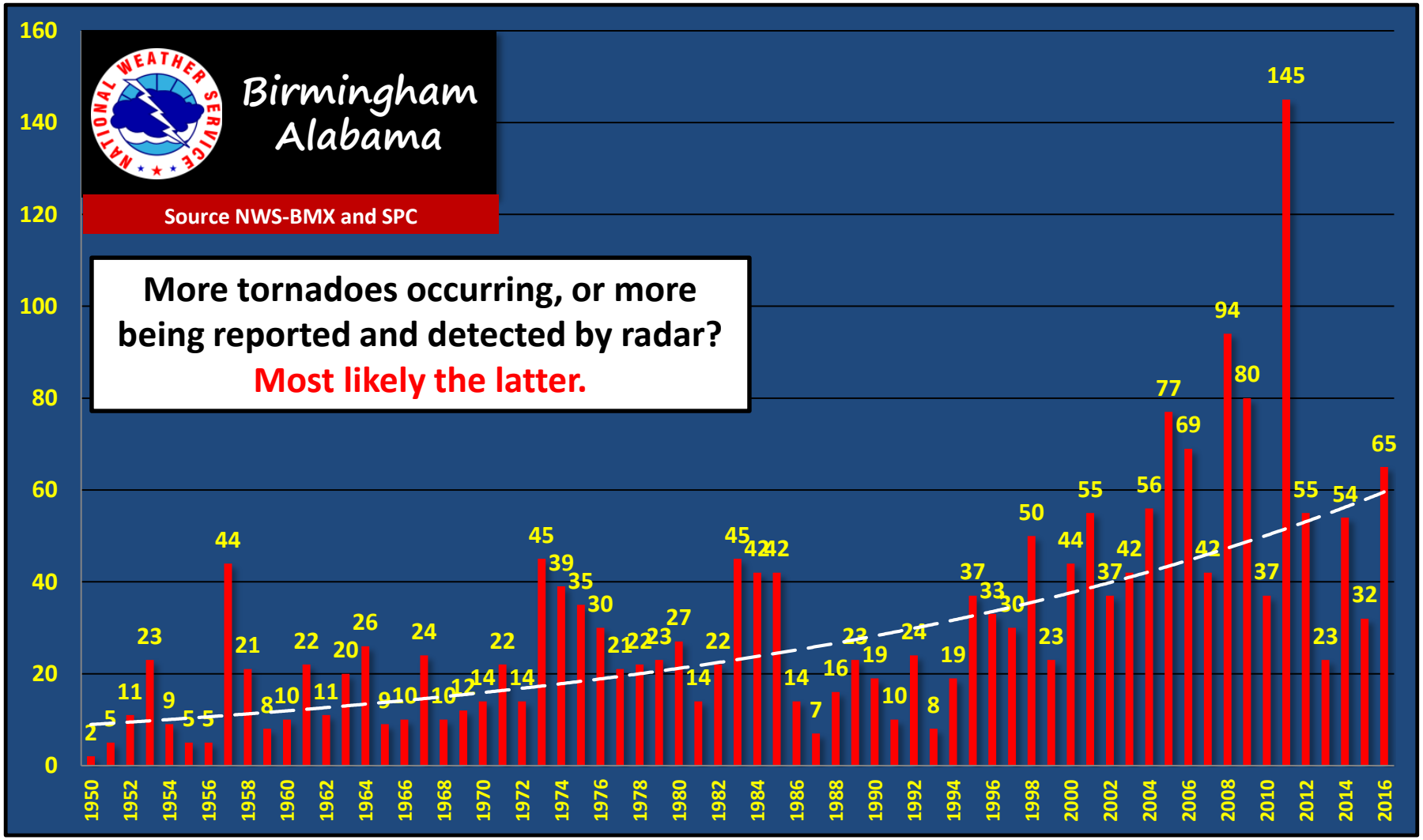
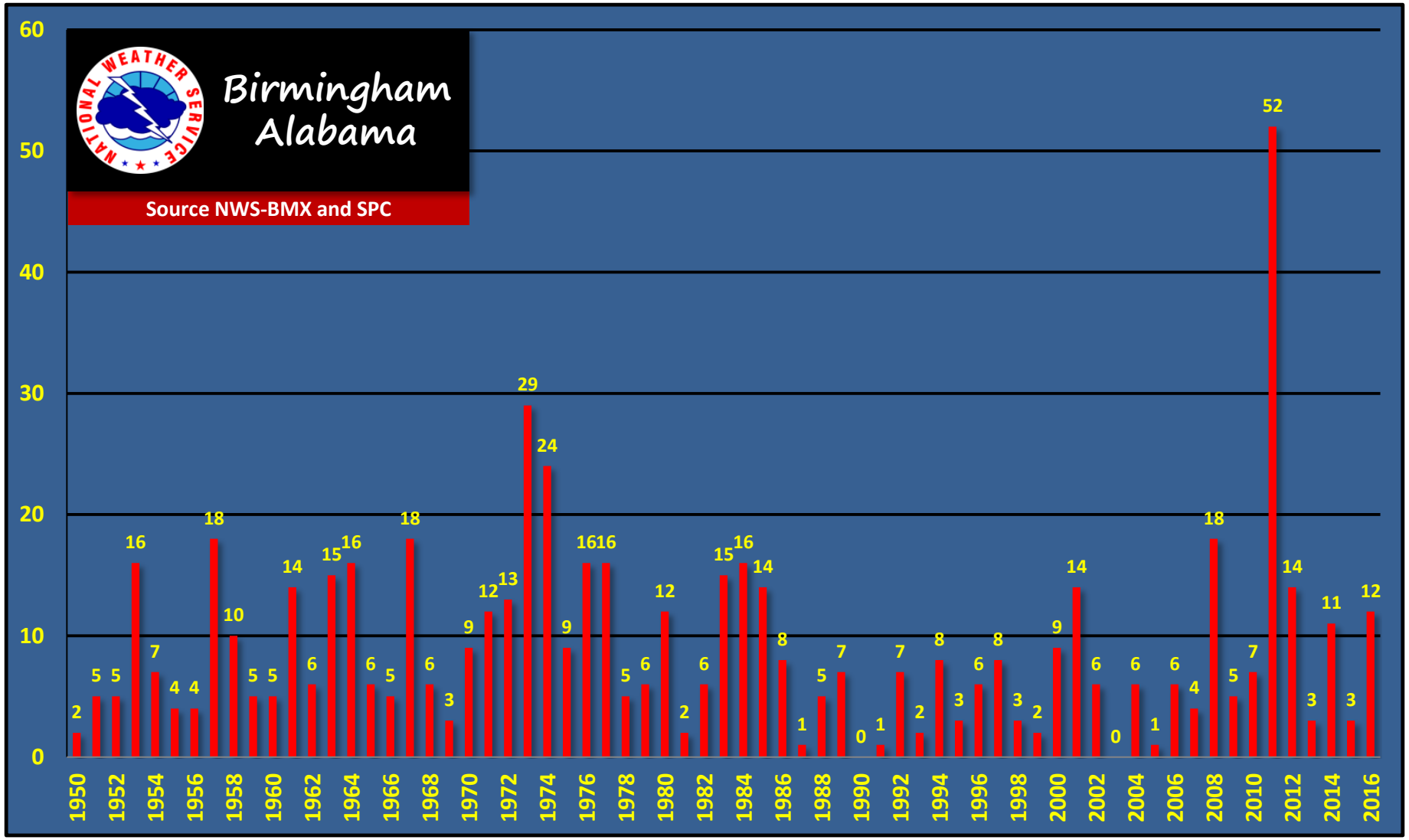


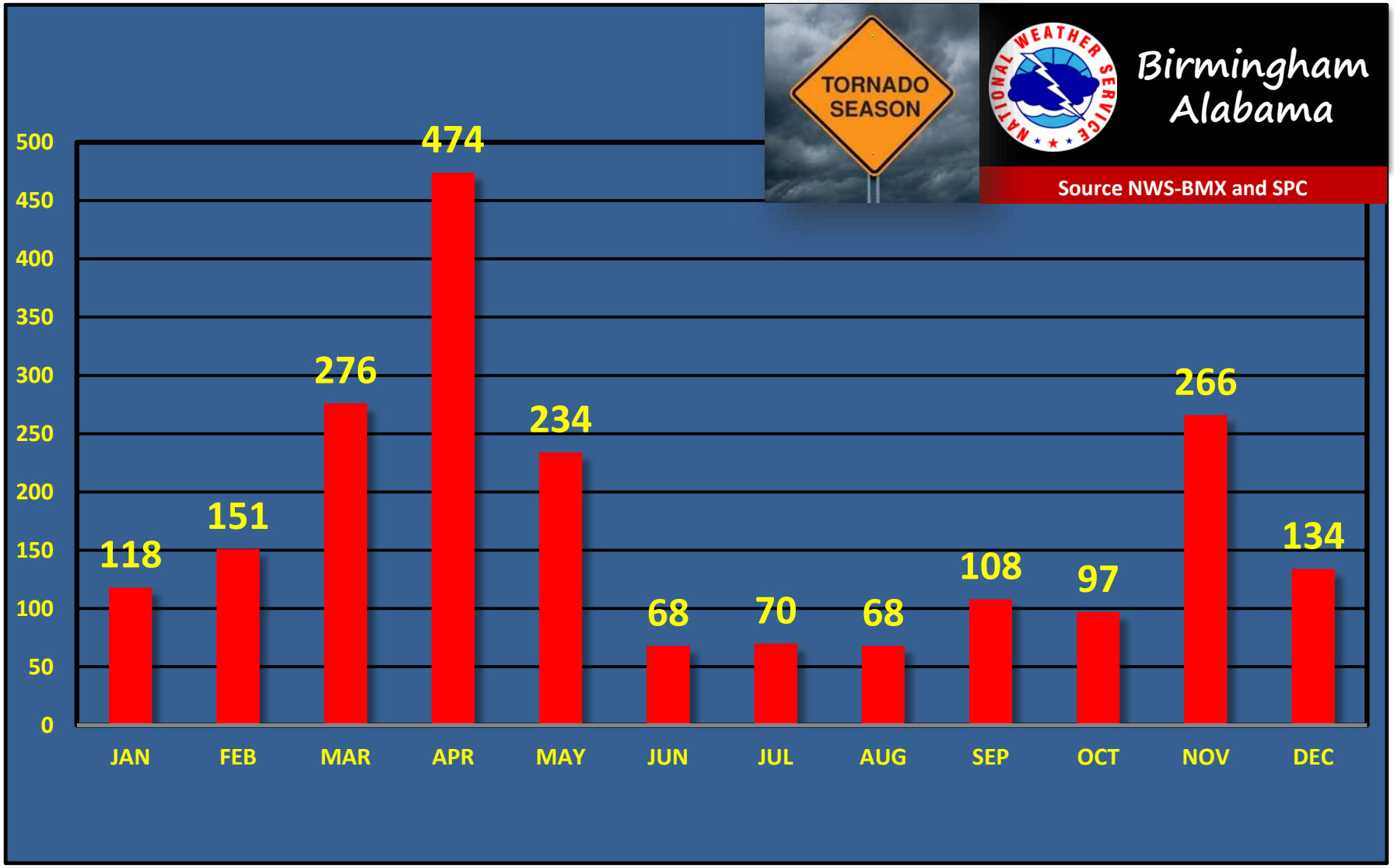
Alabama Tornadoes
Year 1950-2016



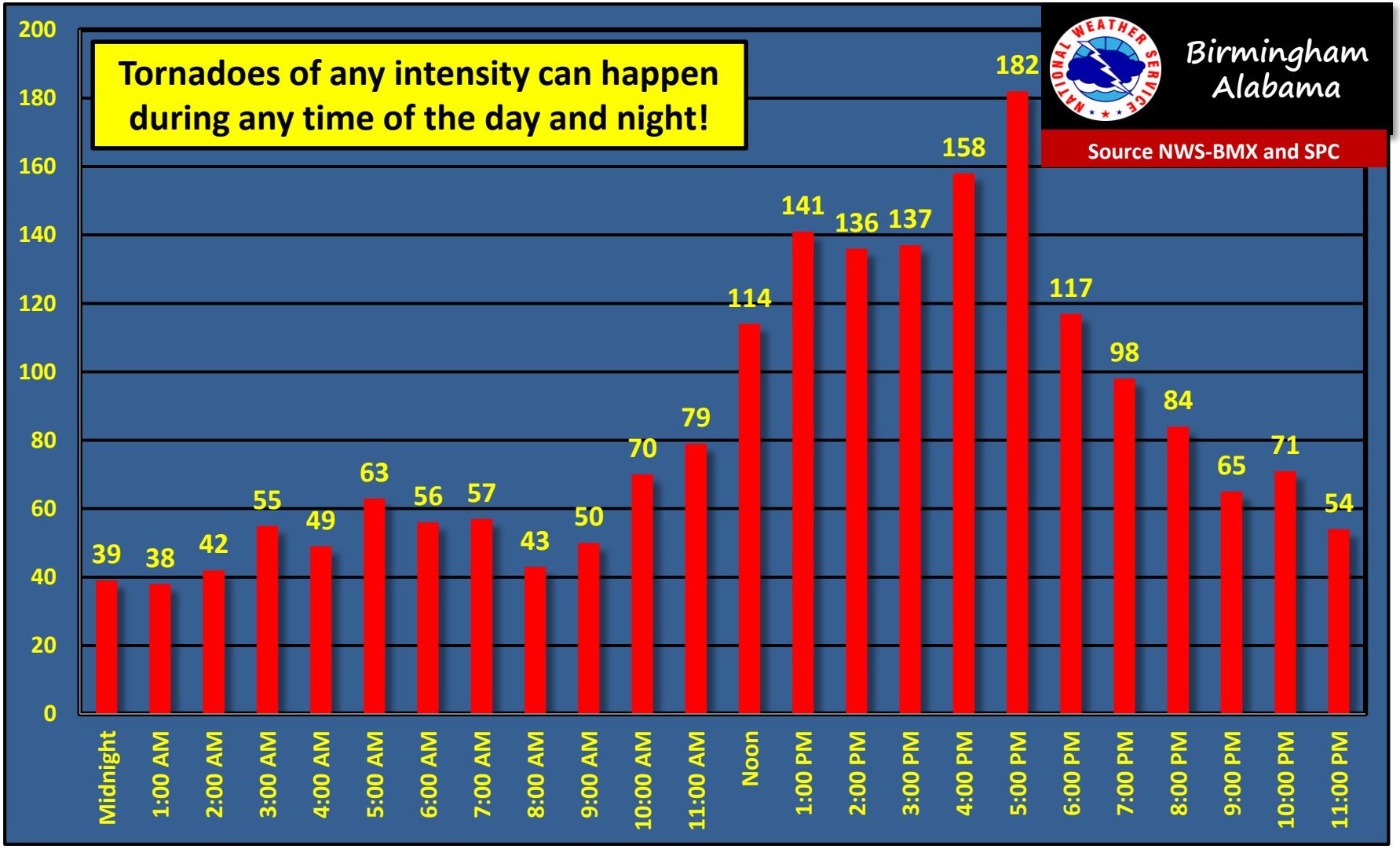
Alabama Tornadoes
EF2 or Stronger by Year 1950-2016



Alabama Tornadoes by Month 1950-2016



Alabama Tornadoes by Hour 1950-2016



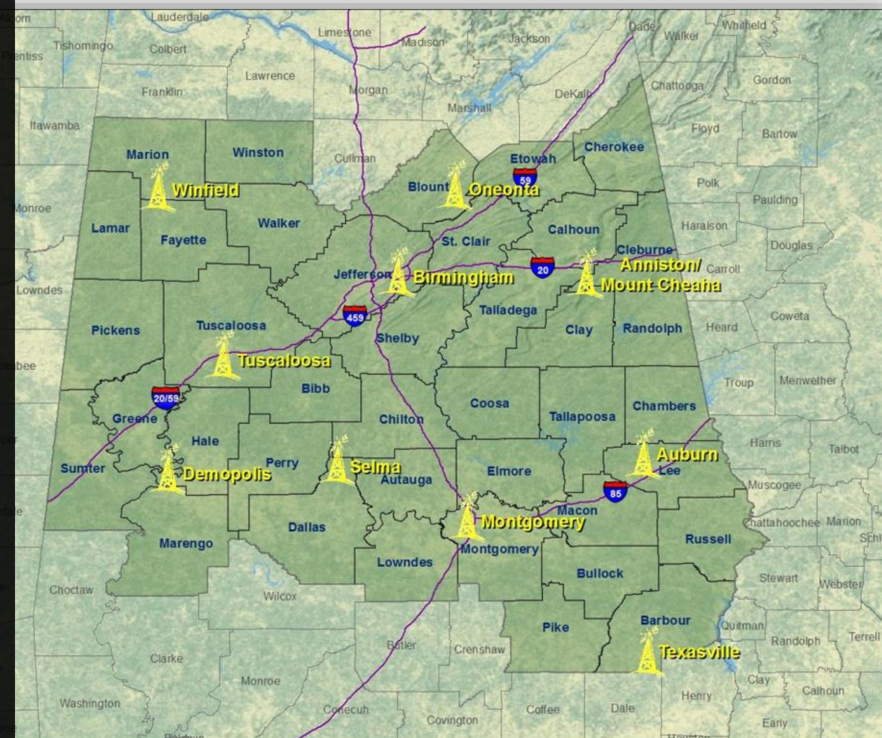
10 Weather Radio Transmitters in Central Alabama

The fastest way to receive our watches and warnings! Will interrupt regular 24/7 broadcast with tone alerts.

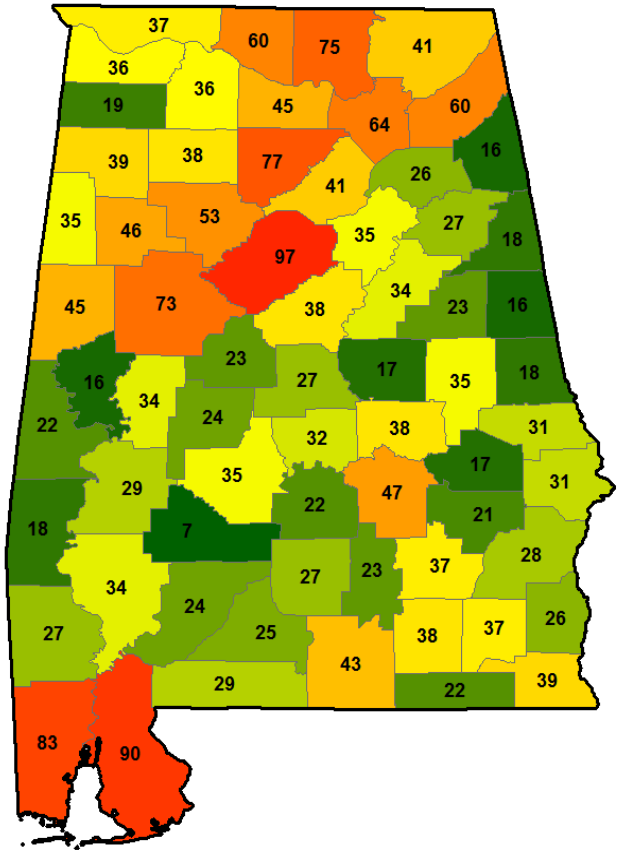
Alerts will wake you at night/when sleeping!

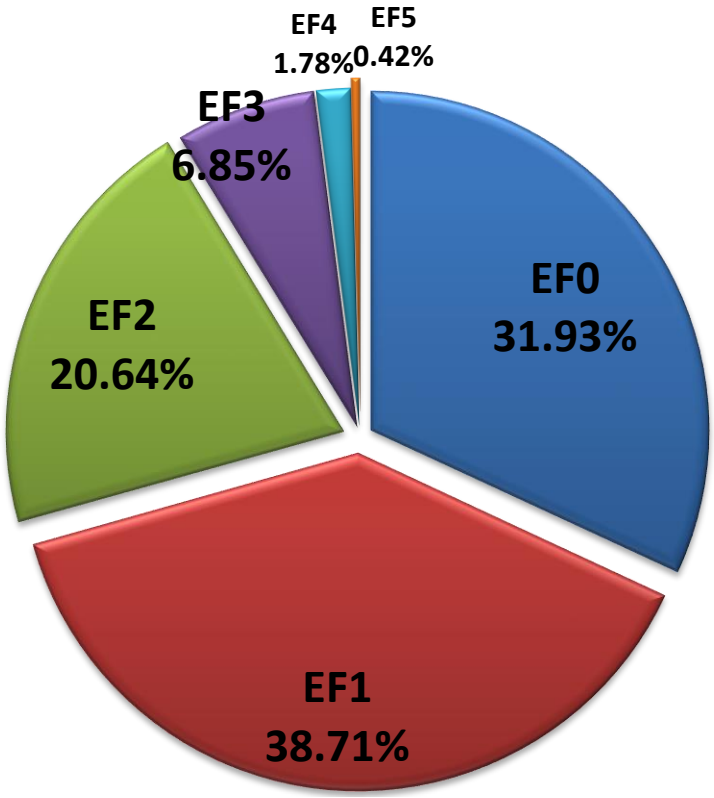
SAME (Specific Area Message Encoding) technology lets you decide which locations to receive warnings for.

Weather radio information available on our webpage, click the ‘Wx Radio’ button at the bottom of the page.



Alabama Tornadoes by County and Percent EF-scale 1950-2016



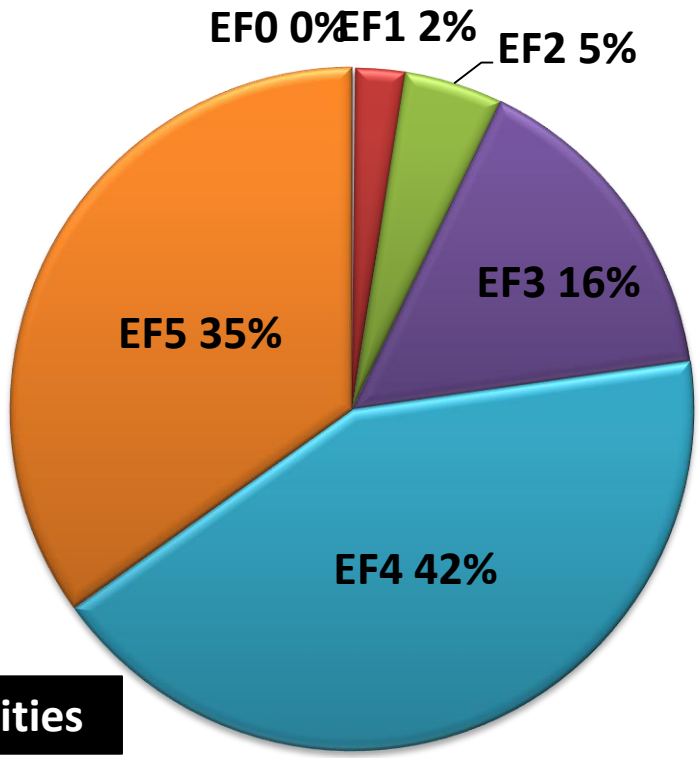


Rating	Winds
EF0	65-85 mph
EF1	86-110 mph
EF2	111-135 mph
EF3	136-165 mph
EF4	166-200 mph
EF5	> 200 mph

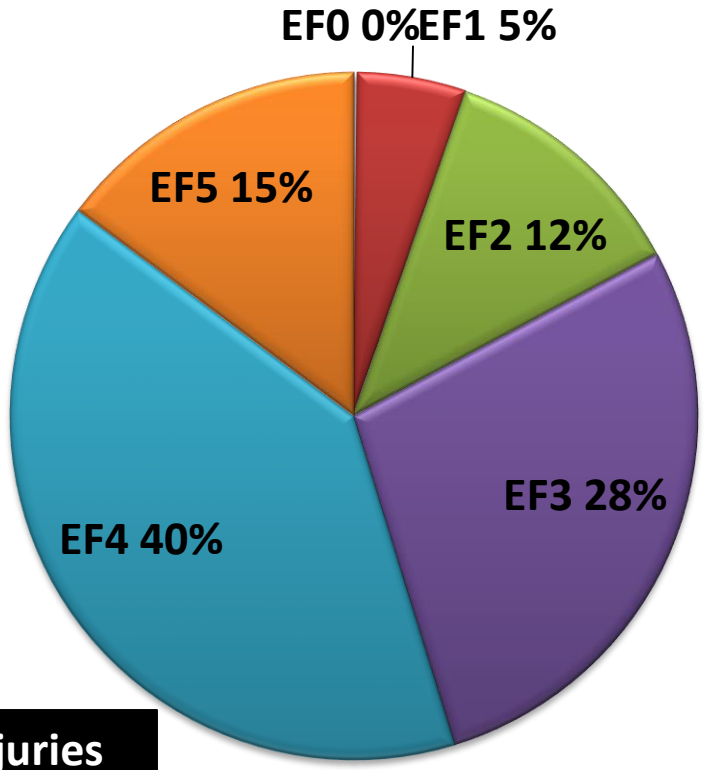
Source NWS-BMX and SPC

Birmingham Alabama

Alabama Tornadoes Injuries and Fatalities by Tornado Intensity 1950-2016



Fatalities



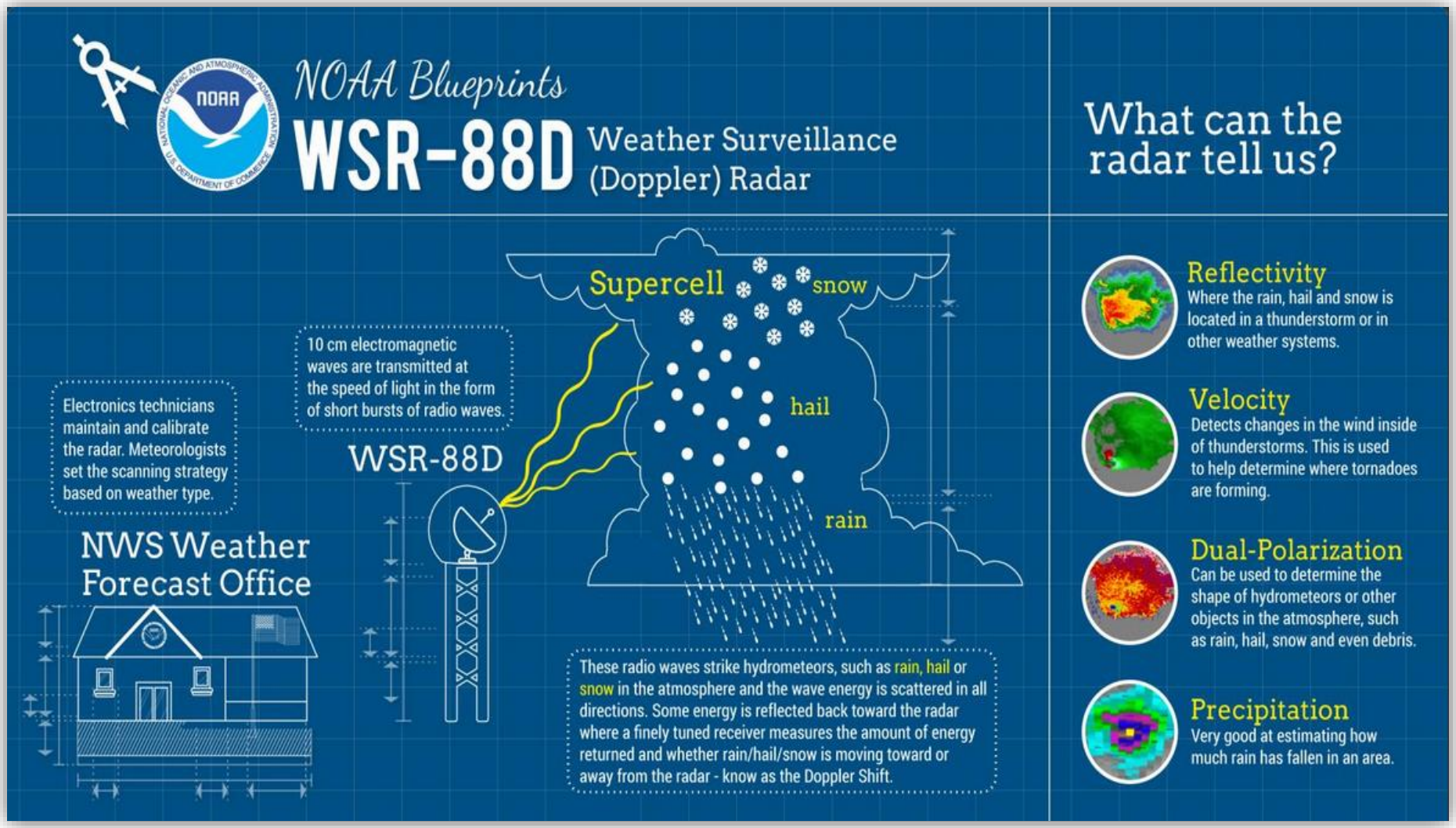
Injuries

Majority of injuries and fatalities occur with violent (EF4-EF5) tornadoes, though they are least common (combined 2.2% of all tornadoes in Alabama) . **Sheltering matters!**

Birmingham Alabama

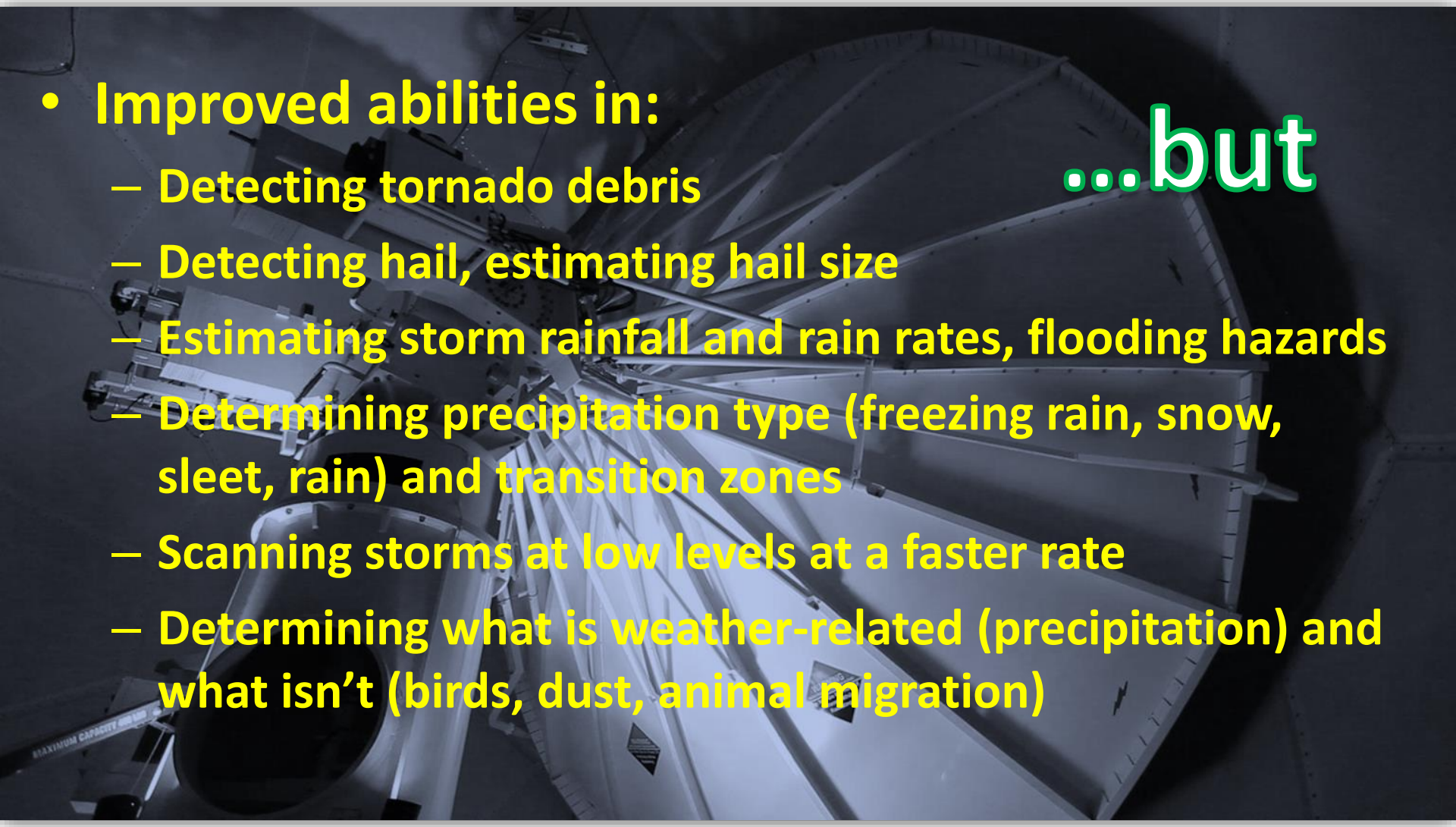
Source NWS-BMX and SPC

Considering all of these Storms, how do we Detect Severe Weather?



How do we Detect Severe Weather?

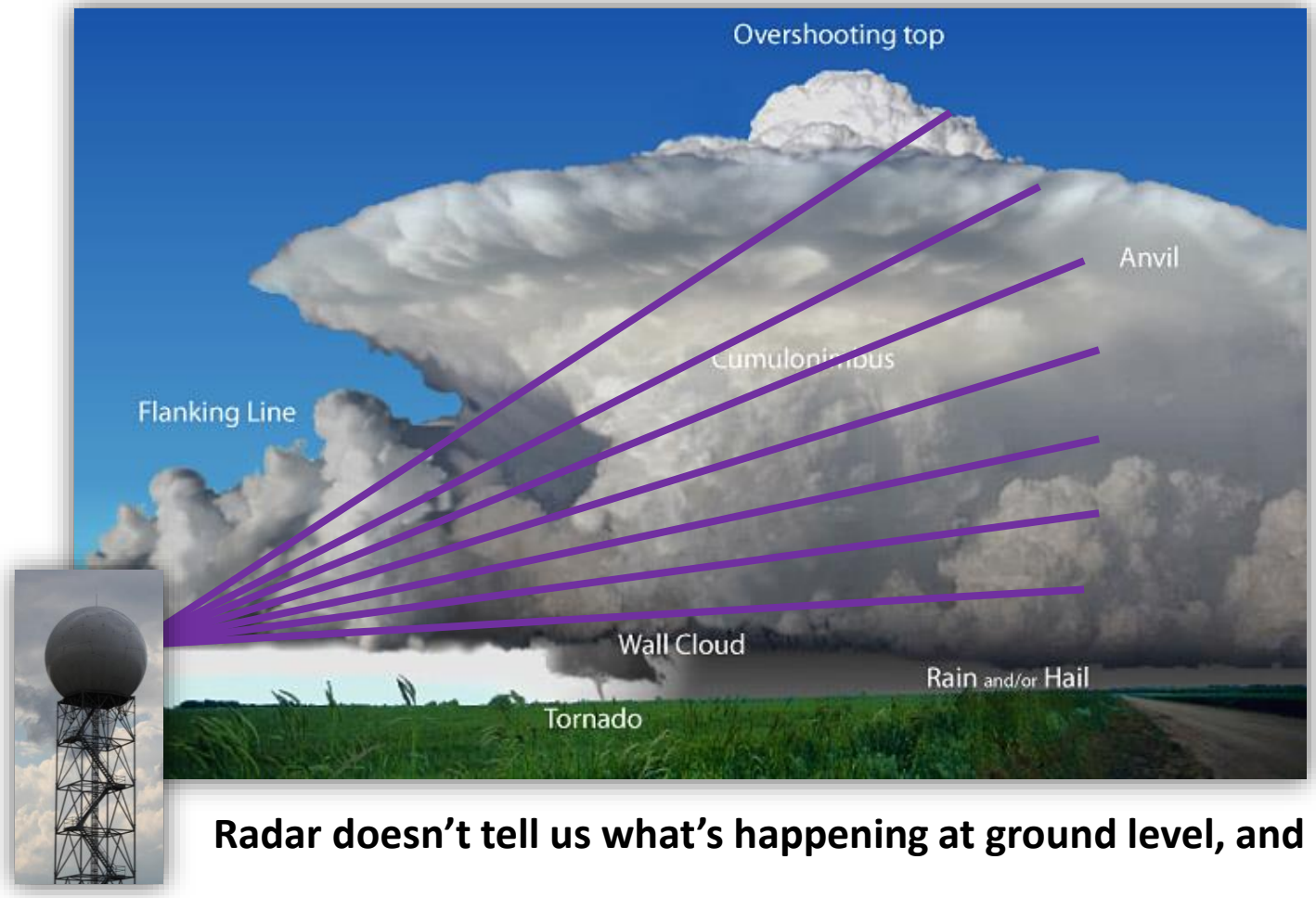
Recent advancements in radar technology



- Improved abilities in:
  - Detecting tornado debris
  - Detecting hail, estimating hail size
  - Estimating storm rainfall and rain rates, flooding hazards
  - Determining precipitation type (freezing rain, snow, sleet, rain) and transition zones
  - Scanning storms at low levels at a faster rate
  - Determining what is weather-related (precipitation) and what isn't (birds, dust, animal migration)

...but

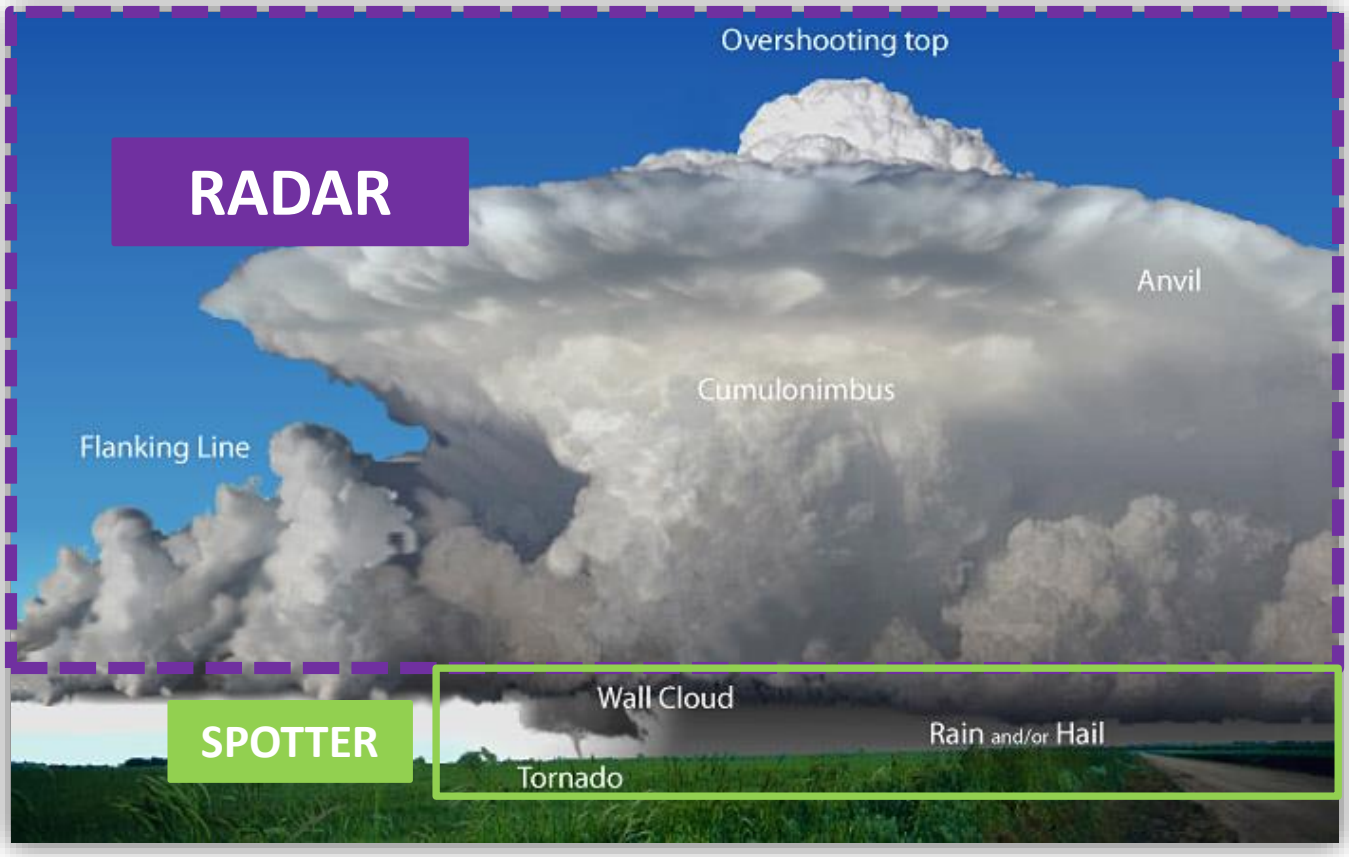
What about Below the Radar Beam?
Spotters Help Tell the Story



Radar doesn't tell us what's happening at ground level, and

…with increasing distance from the radar, it can become even more difficult to completely assess the storm.

What about Below the Radar Beam?
Spotters Help Tell the Story



Radar tells us the storm is capable of producing strong winds, hail, and/or a tornado

Spotters help confirm if the storm is producing damaging winds, hail, and/or a tornado

Spotters Principles

- **Personal safety is the primary objective of every spotter**
- **Adhere to the concept of ACES at all times**

  Awareness-**C**ommunication-**E**scape Route-**S**helter
- **Obey federal, state, and local laws; directives from public safety officials**
- **Never put yourself in harm's way**
- **Remain aware of the weather situation around you!**

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Important Definitions

OUTLOOK

Anticipated weather hazards during the next 7 days.
Issued daily and updated as needed.
[Keep Tabs] … Ready

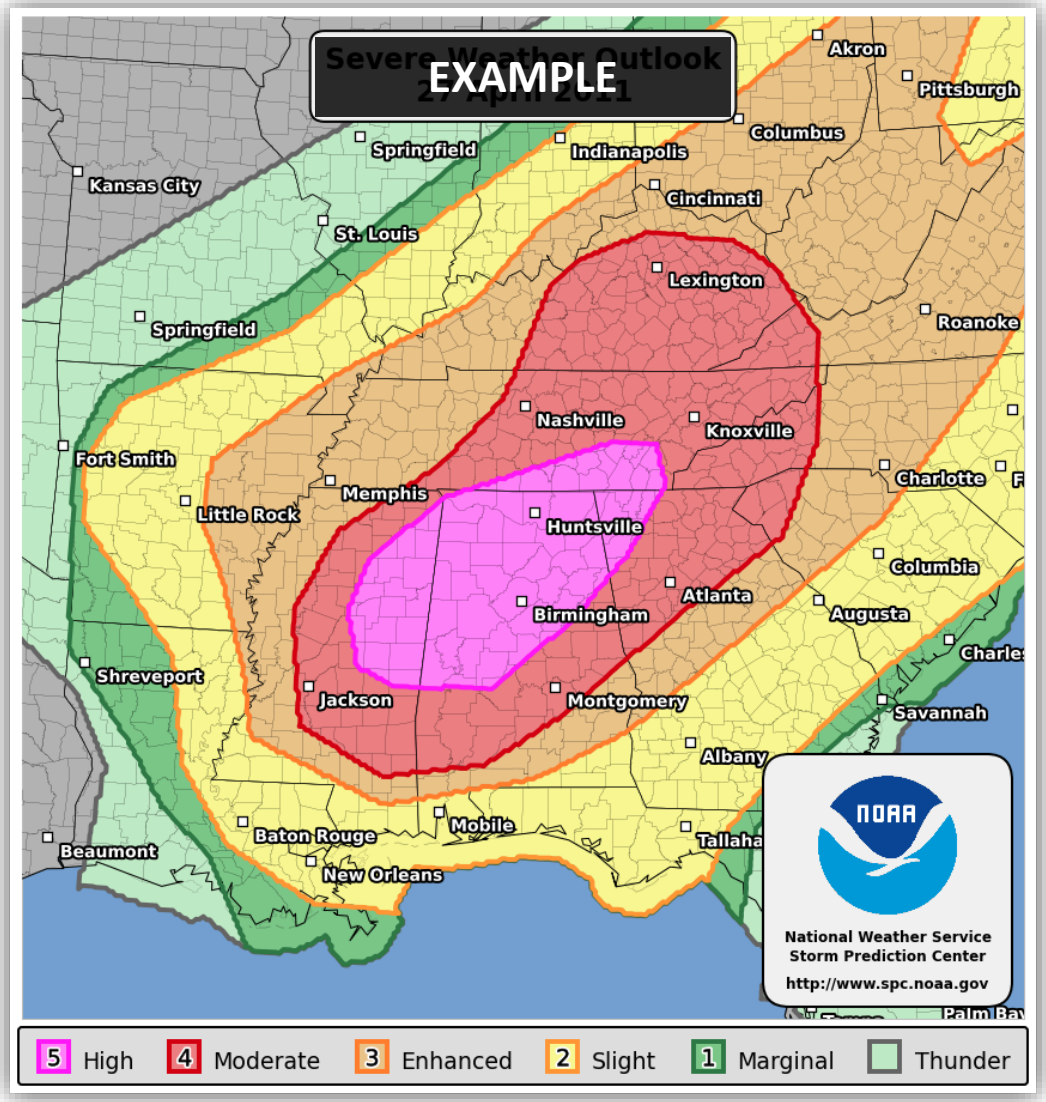
WATCH

Atmospheric conditions are favorable, or could become favorable, for the development of thunderstorms which could produce severe weather.
[Remain Alert] … Set

WARNING

Severe weather is occurring, or is likely to occur.
[Take protective action] … GO!

Storm Prediction Center (SPC) Convective Outlook



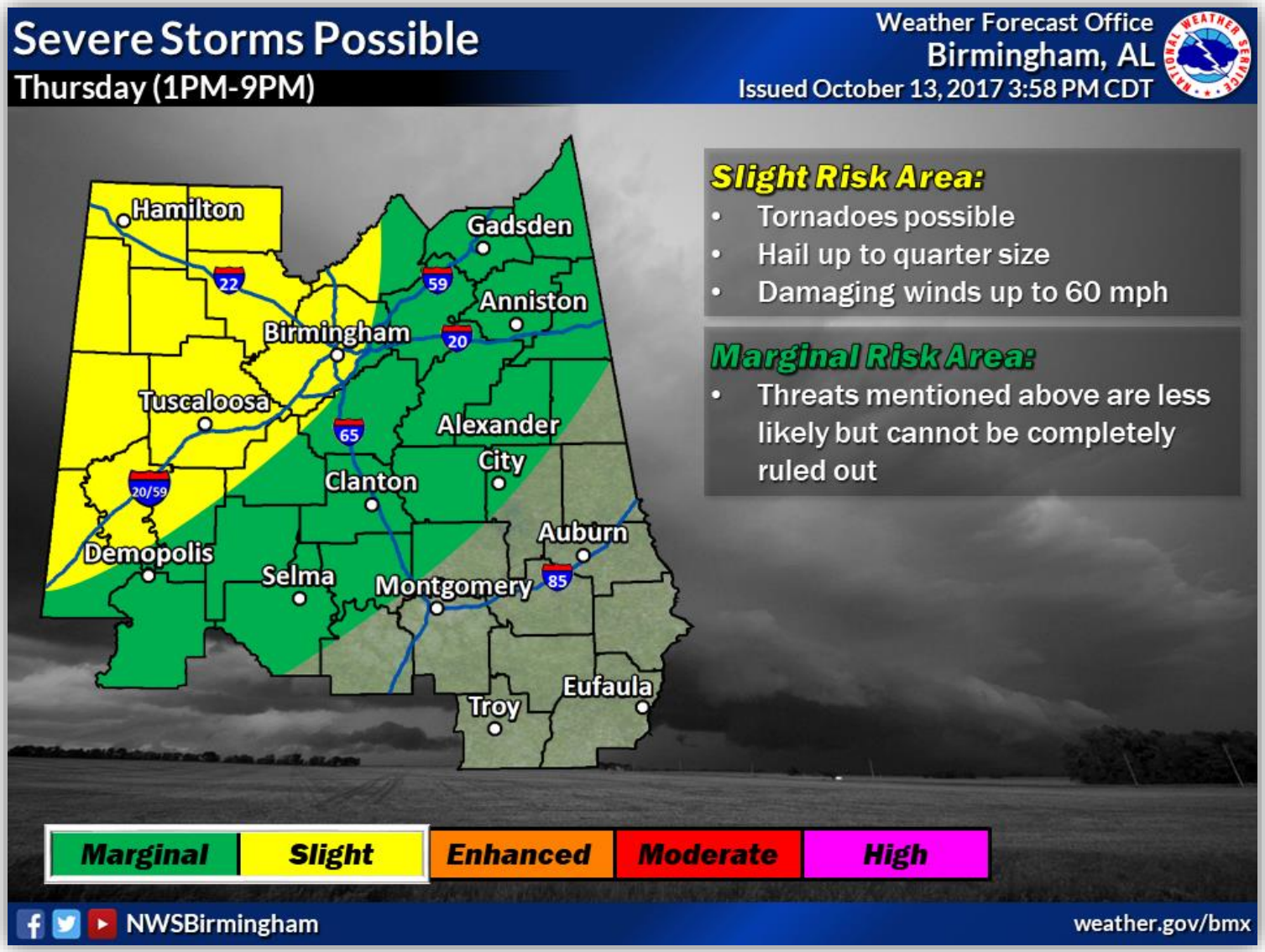
Storm Prediction Center Severe Weather Outlook

Understanding Severe Thunderstorm Risk Categories

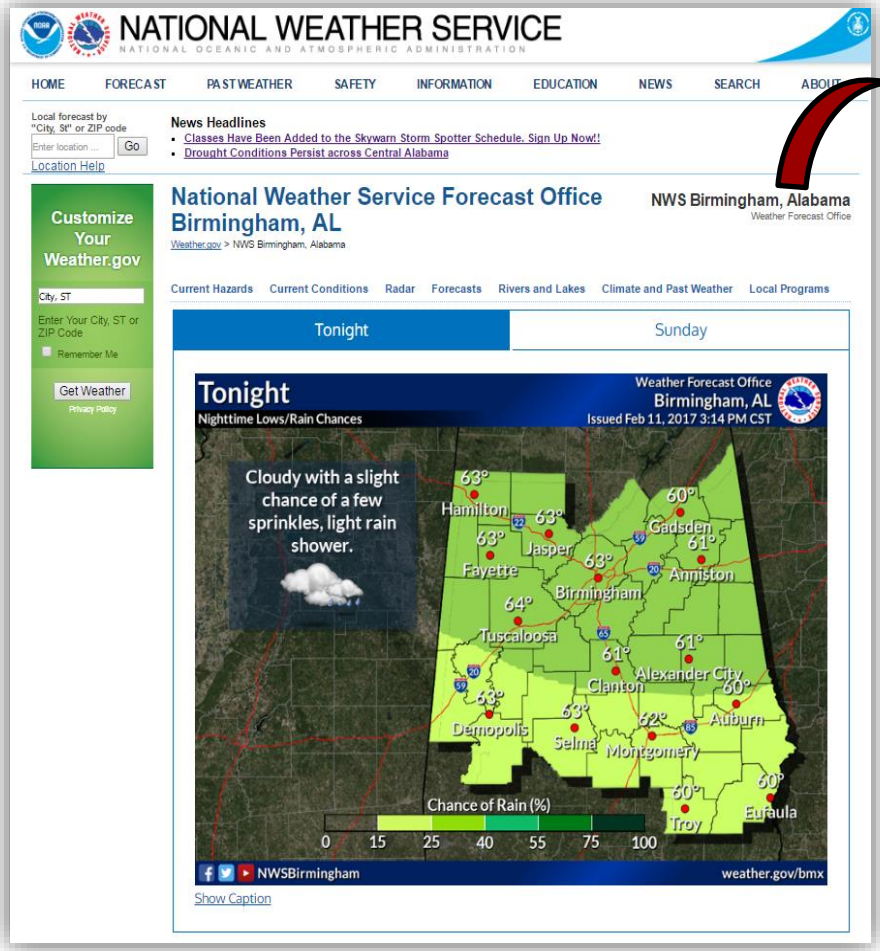
THUNDERSTORMS (no label)	1 - MARGINAL (MRGL)	2 - SLIGHT (SLGT)	3 - ENHANCED (ENH)	4 - MODERATE (MDT)	5 - HIGH (HIGH)
No severe* thunderstorms expected	**Isolated severe thunderstorms possible**	**Scattered severe storms possible**	**Numerous severe storms possible**	**Widespread severe storms likely**	**Widespread severe storms expected**
Lightning/flooding threats exist with <u>all</u> thunderstorms	Limited in duration and/or coverage and/or intensity	Short-lived and/or not widespread, isolated intense storms possible	More persistent and/or widespread, a few intense	Long-lived, widespread and intense	Long-lived, very widespread and particularly intense
					
• *Winds to 40 mph* • *Small hail*	• *Winds 40-60 mph* • *Hail up to 1”* • *Low tornado risk*	• *One or two tornadoes* • *Reports of strong winds/wind damage* • *Hail ~1”, isolated 2”*	• *A few tornadoes* • *Several reports of wind damage* • *Damaging hail, 1 - 2”*	• *Strong tornadoes* • *Widespread wind damage* • *Destructive hail, 2” +*	• *Tornado outbreak* • *Derecho*

* NWS defines a severe thunderstorm as measured wind gusts to at least 58 mph, and/or hail to at least one inch in diameter, and/or a tornado. All thunderstorm categories imply lightning and the potential for flooding. Categories are also tied to the probability of a severe weather event within 25 miles of your location.

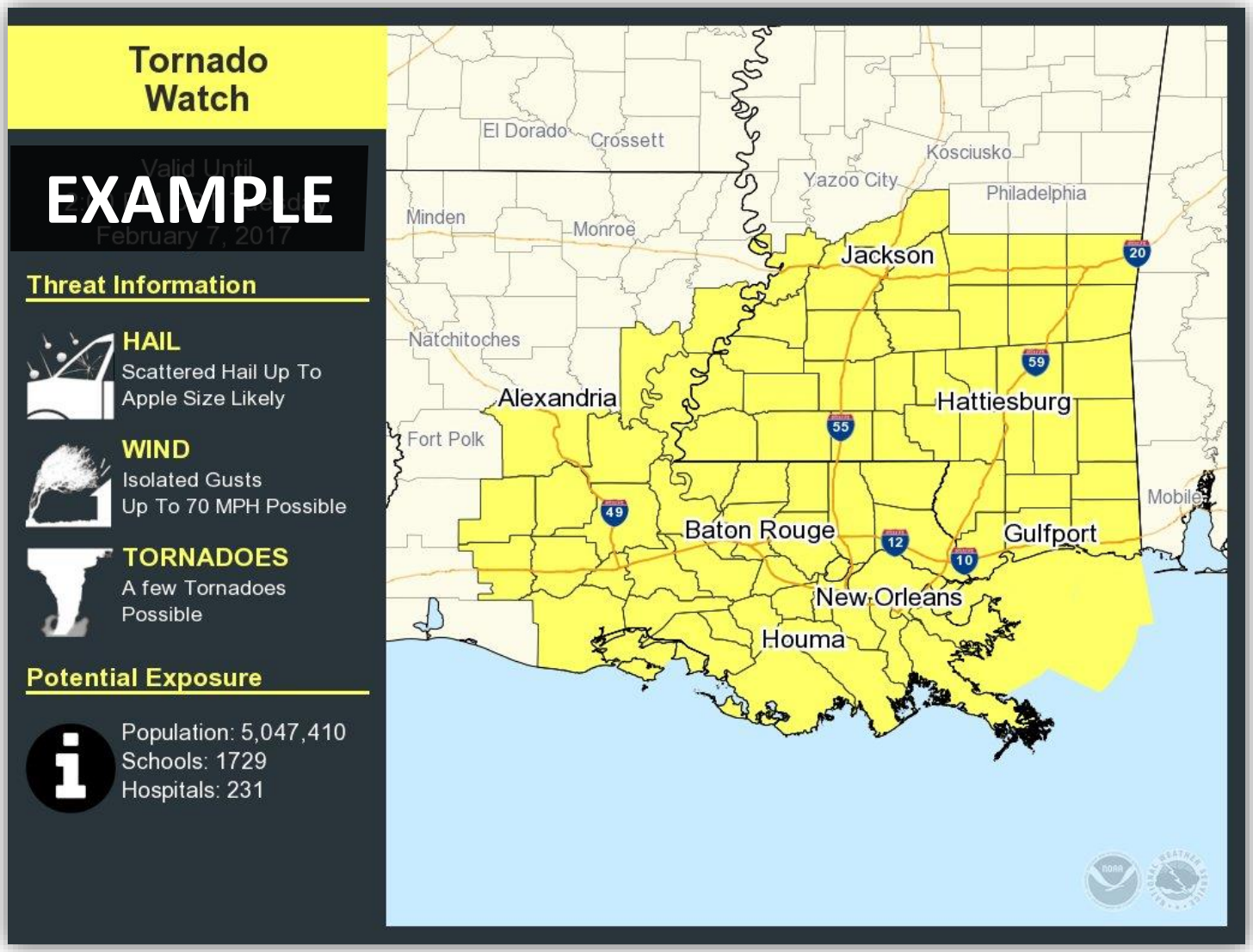
Example Severe Weather Outlook



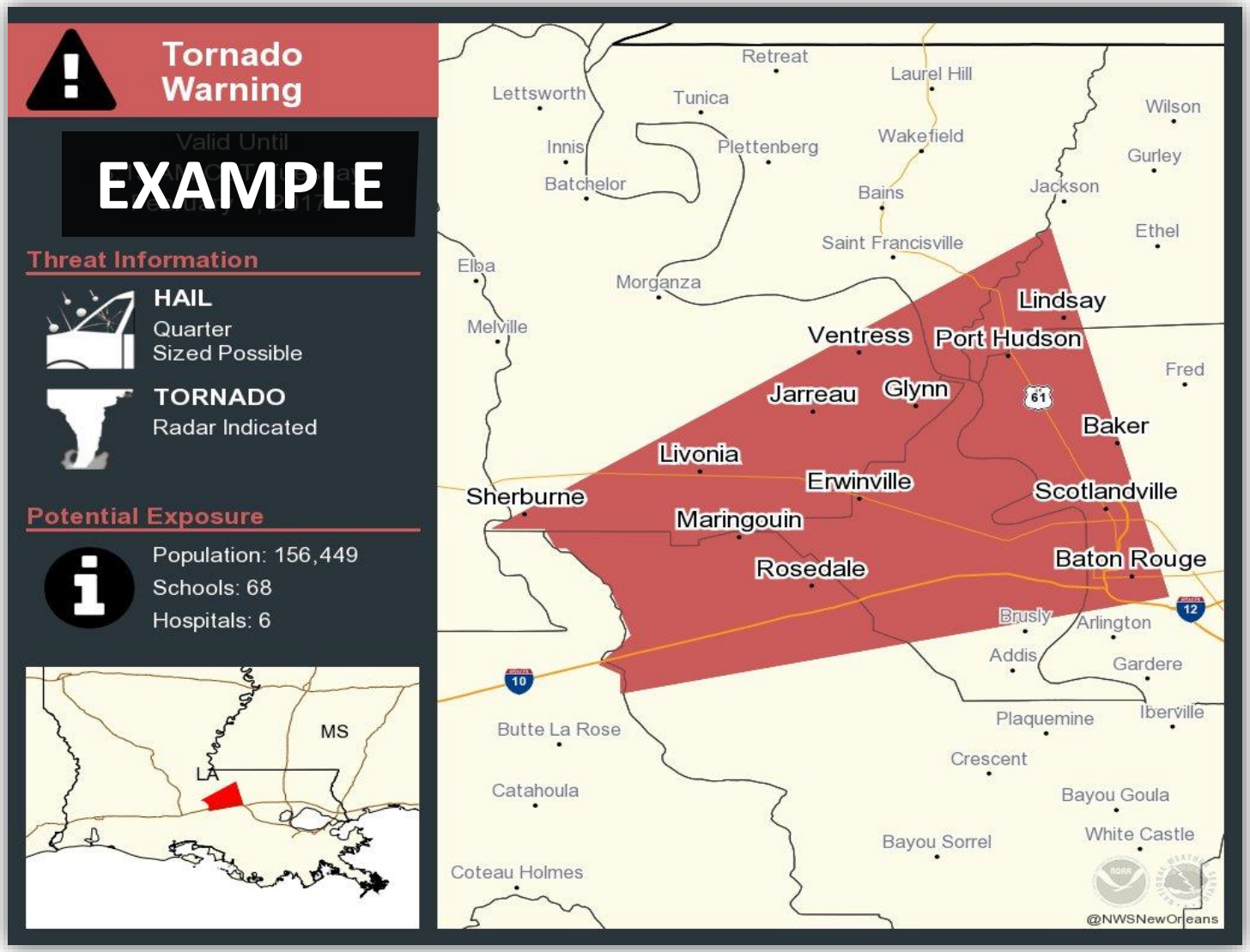
Our Webpage
weather.gov/bmx



Example Watch Area



Example Warning Area



What Makes a Storm Severe?

- Wind gusts of 58 MPH or greater, and/or
- Hail 1 inch or more in diameter

Severe Thunderstorm Warning is issued for potential of this occurring, or if observed

- A tornado also makes a storm severe

Tornado Warning is issued for potential of this occurring, or if observed

Lightning does not make a thunderstorm severe

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What to Report – Wind

Wind damage is just as important as wind speed. Specify if wind is *measured* or *estimated*.

- **Trees or limbs blown down**
- **Power poles or lines blown down**
- **Damage to buildings**

Wind Speed Estimation Guide

25-31 mph - large branches in motion

32-38 mph – whole trees in motion

39-54 mph – twigs break off, wind impedes walking

55-72 mph – damage to chimneys and TV antennas, large branches broken and some trees uprooted

73-112 mph – removes shingles, windows broken, trailer houses overturned, trees uprooted/snapped

113+ mph – roofs torn off, weak buildings and trailer houses destroyed, large trees uprooted/snapped

What to Report – Hail

Report the largest size hail stone you see.

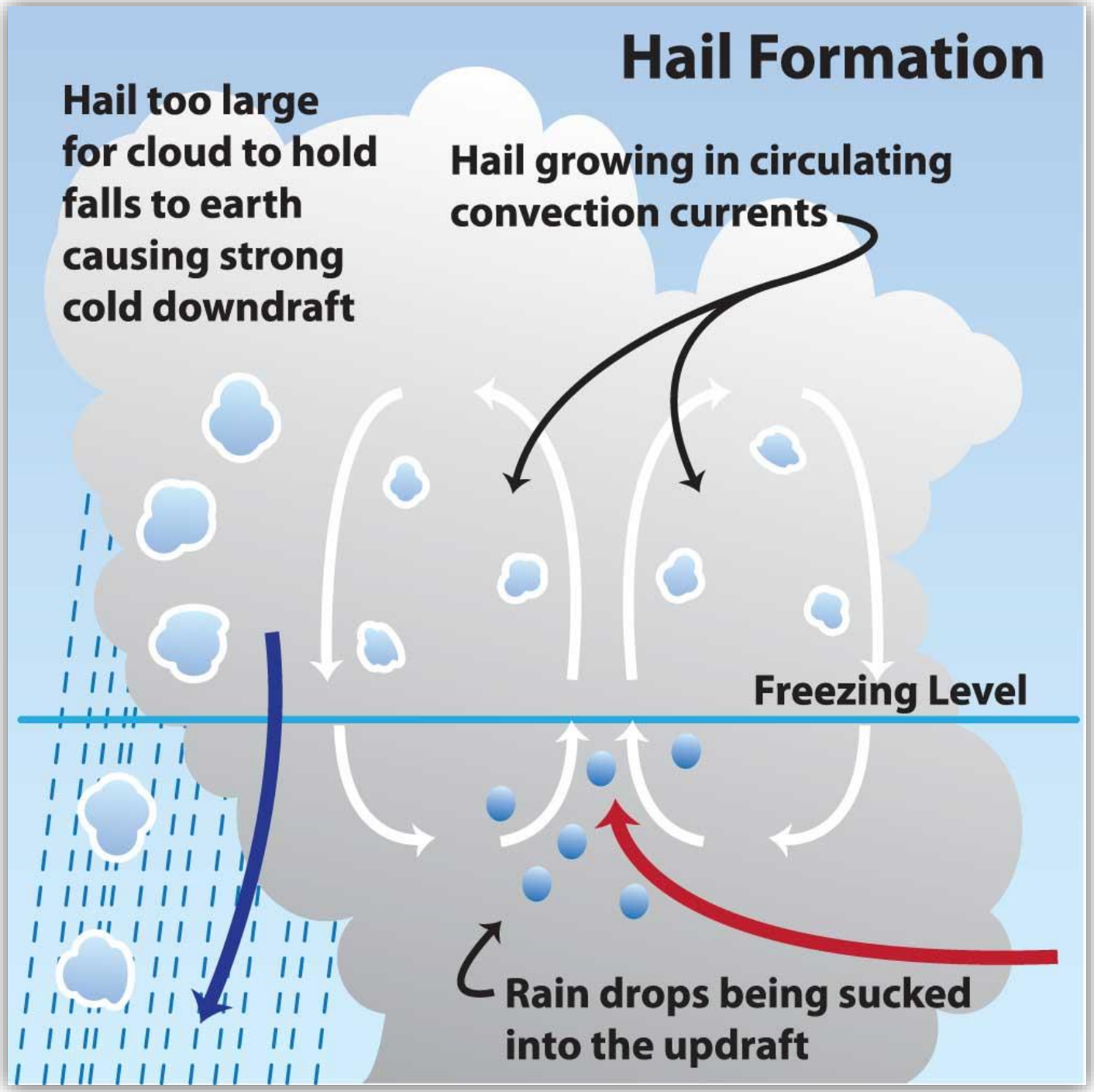
Provide a measurement in inches, or reference a common item (e.g., quarter, golf ball, tennis ball).

Do not report marbles!

Hail Size Chart

While the National Weather Service encourages the actual measurement of hail size, oftentimes, an object-to-size conversion can provide important information about hail from a severe weather event. Below, you will find a list of common objects used to describe the diameter of observed hail.

0.25 inches Pea		2.00 inches Hen Egg	
0.75 inches Penny		2.50 inches Tennis Ball	
1.00 inches Quarter		2.75 inches Baseball	
1.50 inches Ping Pong Ball		3.80 inches Softball	
1.75 inches Golf Ball		4.50 inches Grapefruit	


Hail Formation
Hail too large for cloud to hold falls to earth causing strong cold downdraft
Hail growing in circulating convection currents
Freezing Level
Rain drops being sucked into the updraft

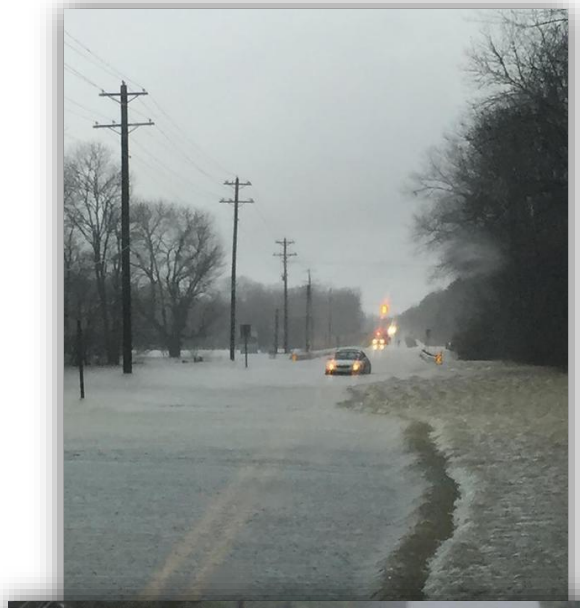
What to Report – Tornado, Funnel Cloud, or Wall Cloud

Definitions and additional information coming up!

What to Report – Flash Flooding

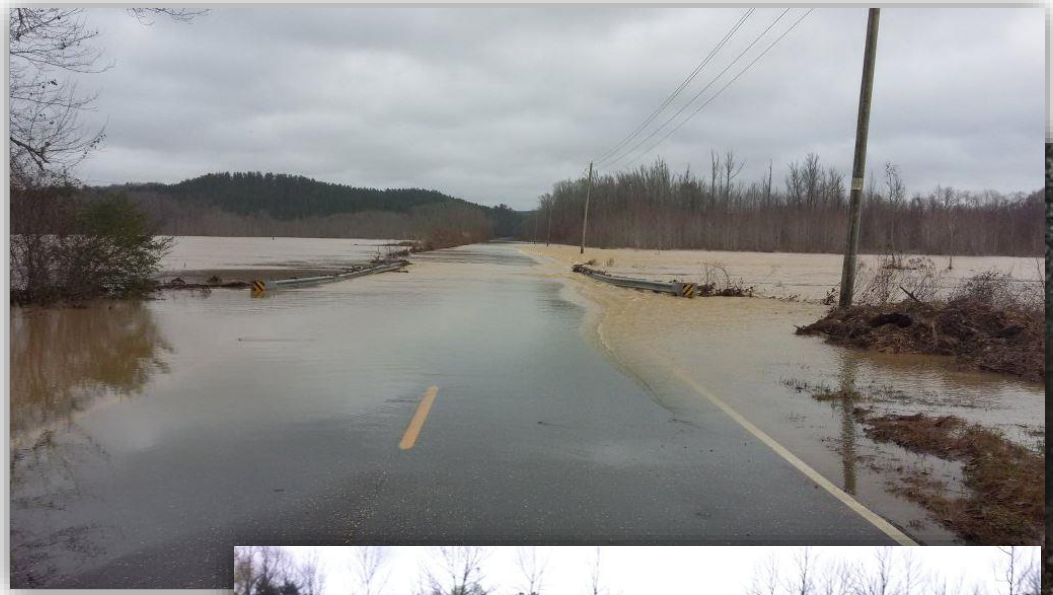
- A rapid rise, out-of-banks flow in a river or stream that is a threat to life or property
- Approx. 6 inches or more of flowing water over a road or bridge
- Any amount of water in contact with, flowing into, or causing damage to an above-ground building
- 3 feet or more of ponded water that poses a threat to life or property

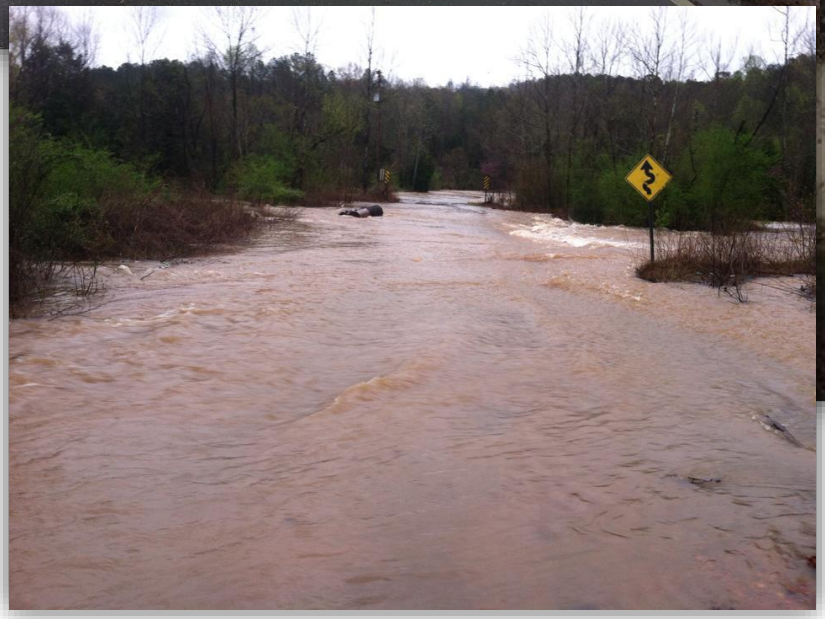
Above items must occur within 6 hours of the causative event, such as heavy rain, a dam break, or ice jam release



What to Report – Urban Flooding

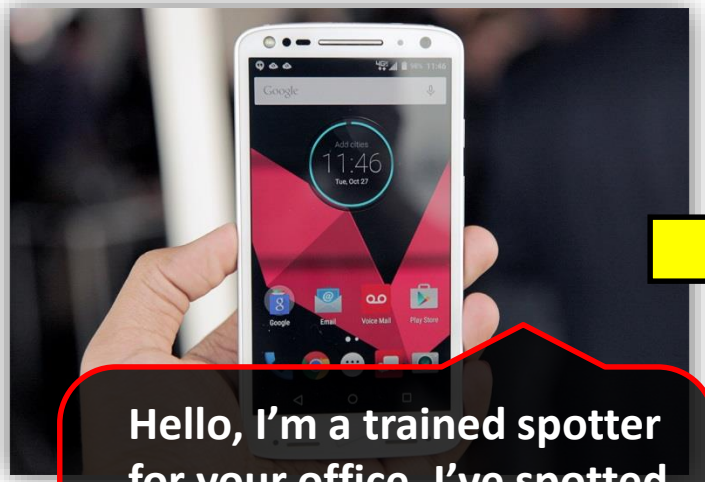
What to Report – Rural Flooding



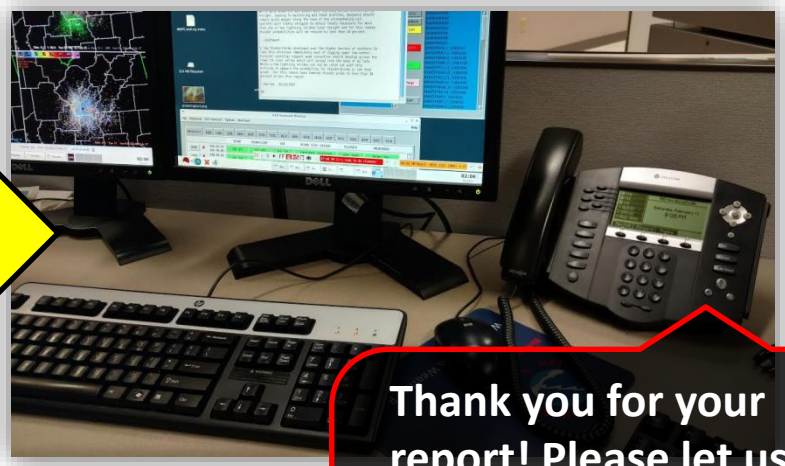


What to Report – Snow or Ice Accumulation

Submit a Report via Phone



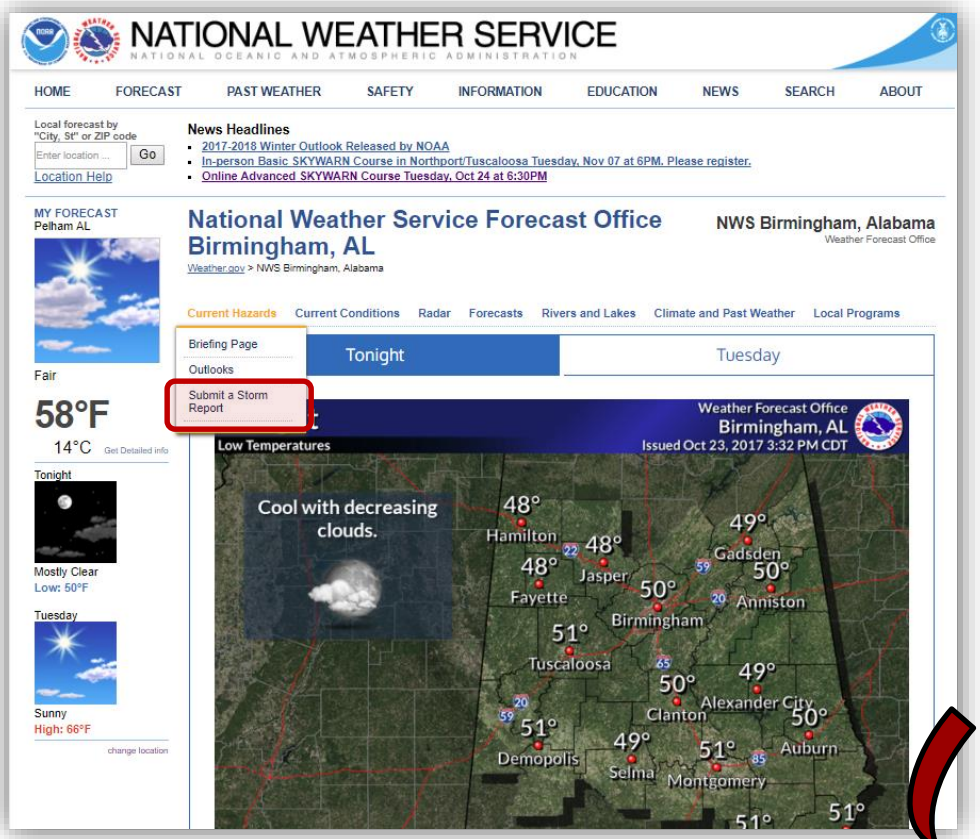
Hello, I'm a trained spotter for your office. I've spotted a wall cloud with strong rotation passing about a mile north of Leeds.

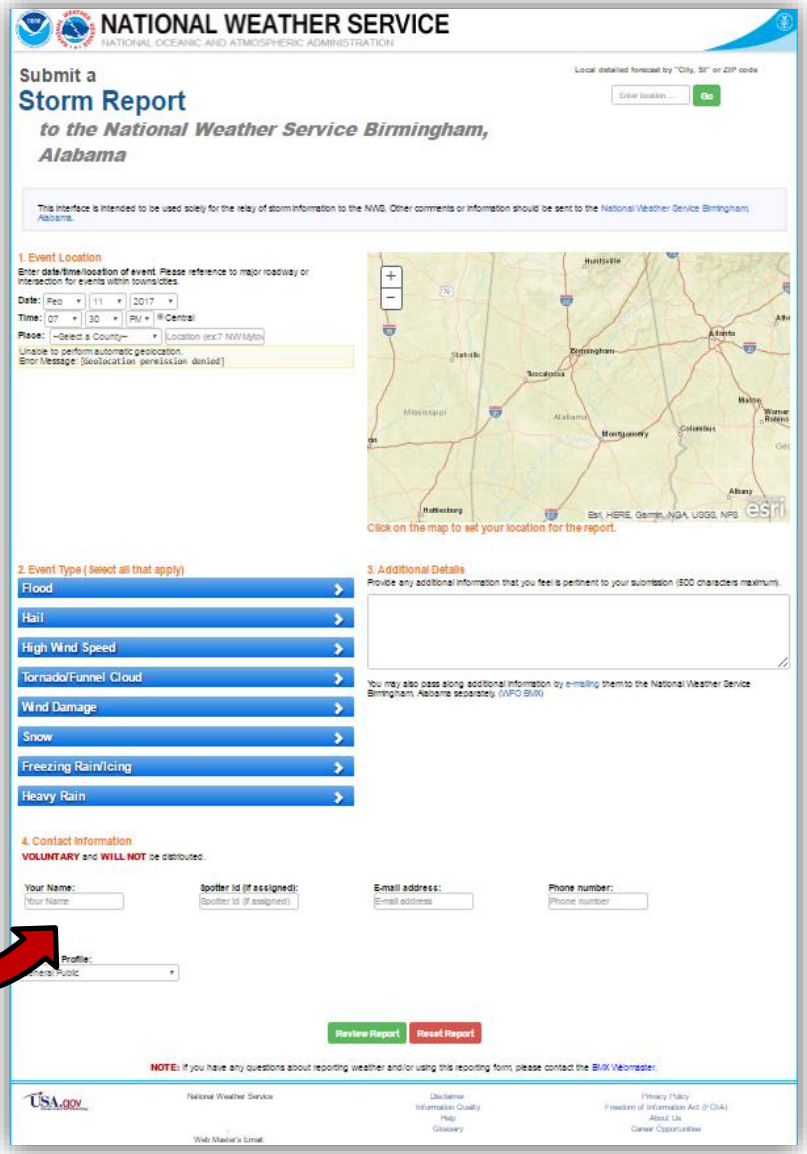


Thank you for your report! Please let us know if you being to see a funnel cloud develop!

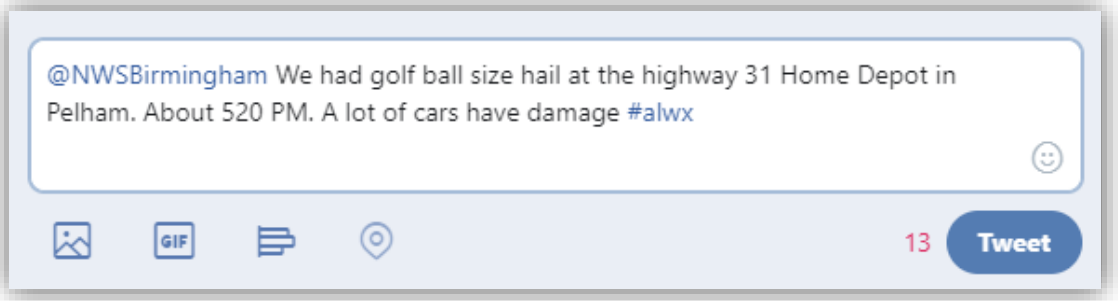
- NWS office phone number: 205-664-3010, option 2
- Your local Emergency Management Office
- Local law enforcement

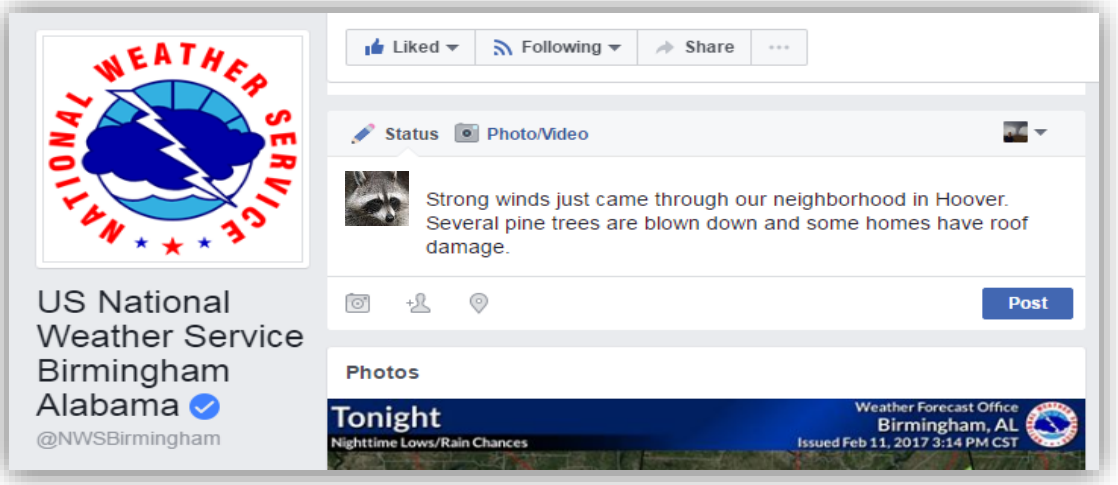
Submit a Report on our Webpage





Submit a Report via Social Media





We monitor social media during severe weather (and good weather). Send us a storm report via Facebook message or wall post; or Twitter via Tweet or direct message.

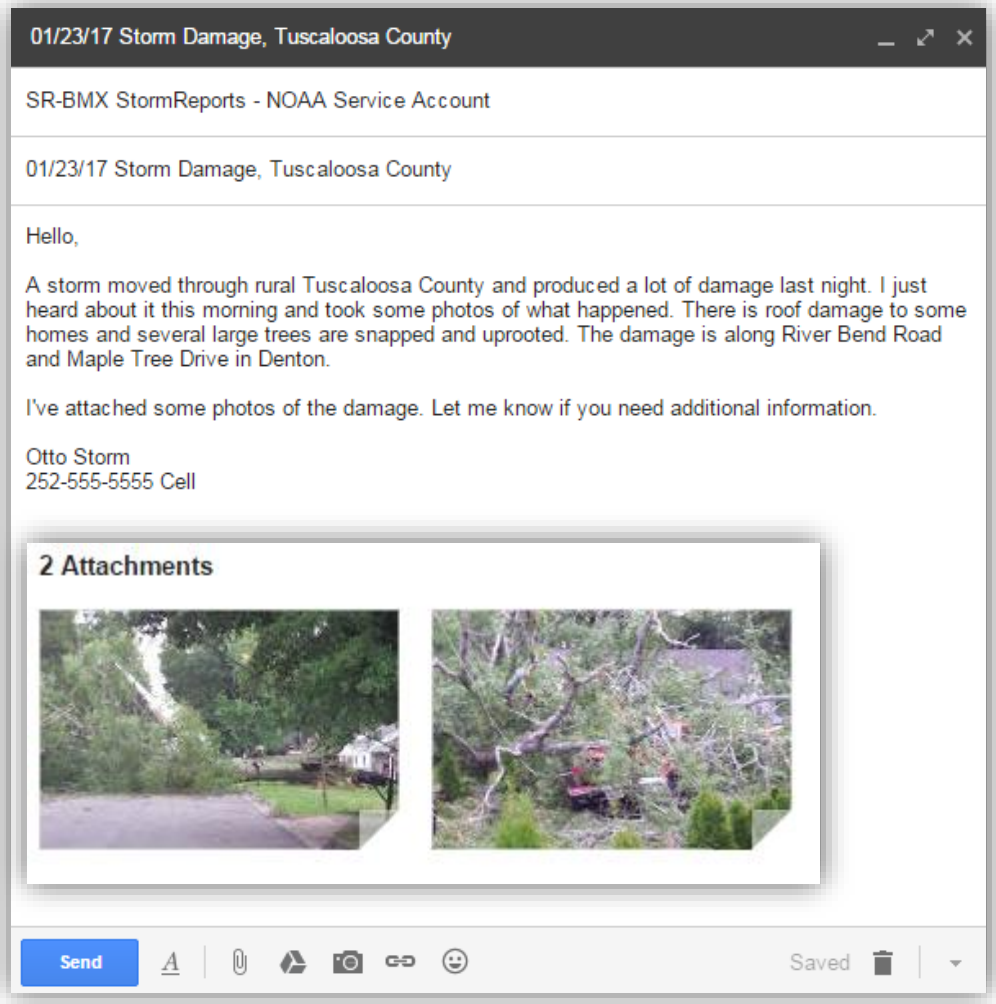
Use *#alwx on Twitter and Facebook*

Submit a Report via Ham Radio
K4NWS

E-mail Option for Photos, Additional Information

sr-bmx.dss@noaa.gov

- Do you have follow-up information?
  - Heard of additional damage in the hours after the storm
  - A more elaborative description of what happened/damage details
  - A series of photos showing damage
- E-mail reports can help us identify areas where damage occurred that we may not yet know about
- Give us a better picture of what's happened



Don't rely on e-mail for urgent reports! Such as large hail, damaging winds, tornado, funnel cloud on-going!

Effective Spotter Report(s)

- Do not assume that if a warning is issued, the NWS knows for certain that severe weather has occurred. We want to hear from you!
- Get your report to us ASAP (and when you are safe). Weather events are time-sensitive!
  - What, When, Where
- Never assume your report is not important!
- Do not exaggerate your report!
- If you are relaying a report, please let us know that you did not witness it first-hand.

Spotter Training Agenda

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--Break--

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Spotter Safety

The safety of you and those around you is more important than any storm report or storm photo

- **Personal safety is the primary objective of every spotter**
- **ACES (A**wareness-**C**ommunication-**E**scape Route-**S**helter)
- **Spot with someone**
- **Obey federal, state, and local laws; directives from public safety officials**
- **Never take shelter under a highway overpass**
- **Remain aware of the weather situation around you!**

Lightning

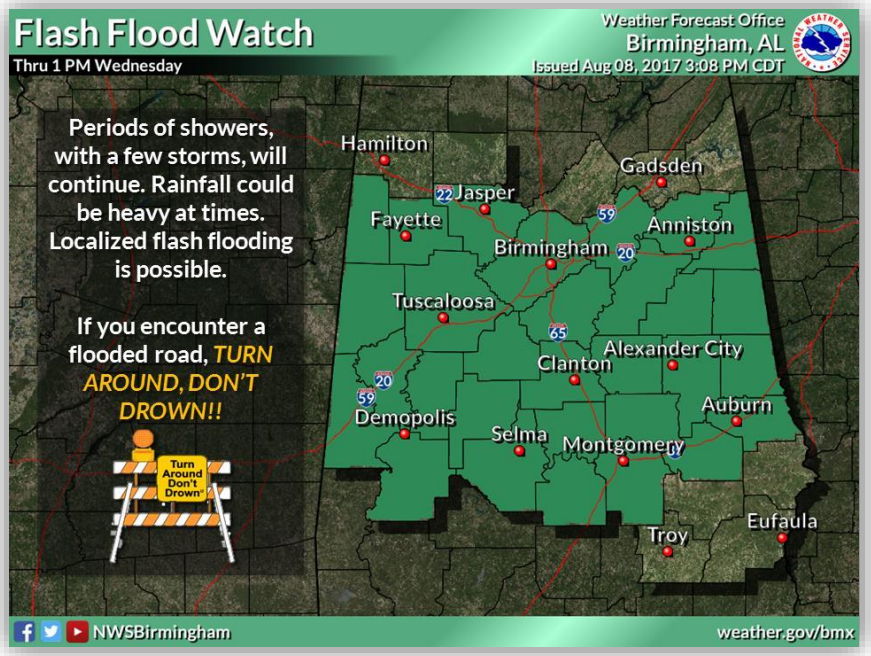
Lightning can be deadly!

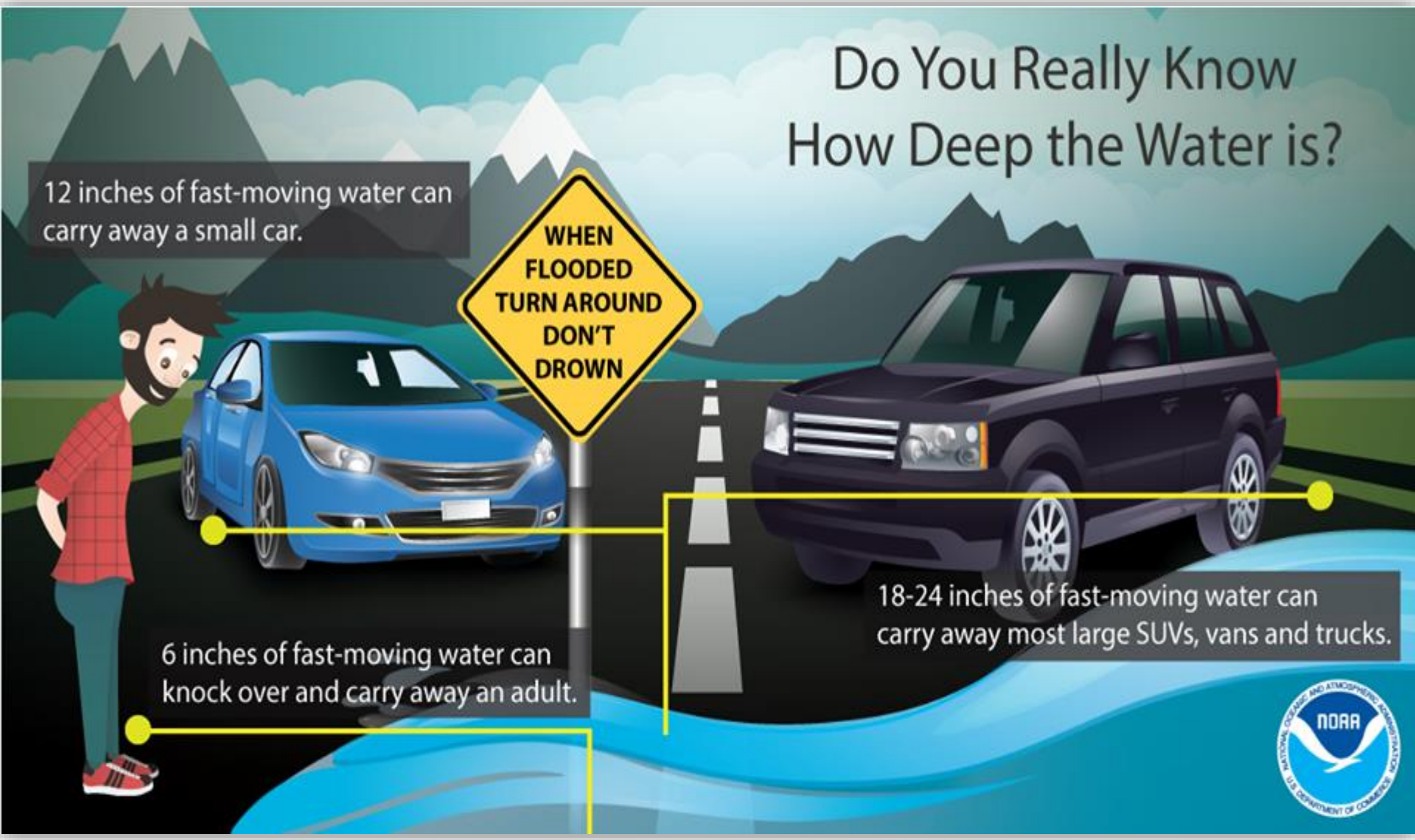
- Lightning can strike as far as 10 miles away from a thunderstorm
- Move inside a building; avoid appliances and metal surfaces
- If outside without shelter, crouch down low (do not lie flat); avoid: tall objects, bodies of water, elevated areas
- Stay in your car

Flash Flooding

Flooding is a leading cause of weather-related deaths in the U.S.

- Never cross water of unknown depth!
  - Road may be washed out or there could be underwater obstructions
- Get to higher ground
- Never cross barriers put in place by emergency officials
- Flood dangers are harder to recognize at night



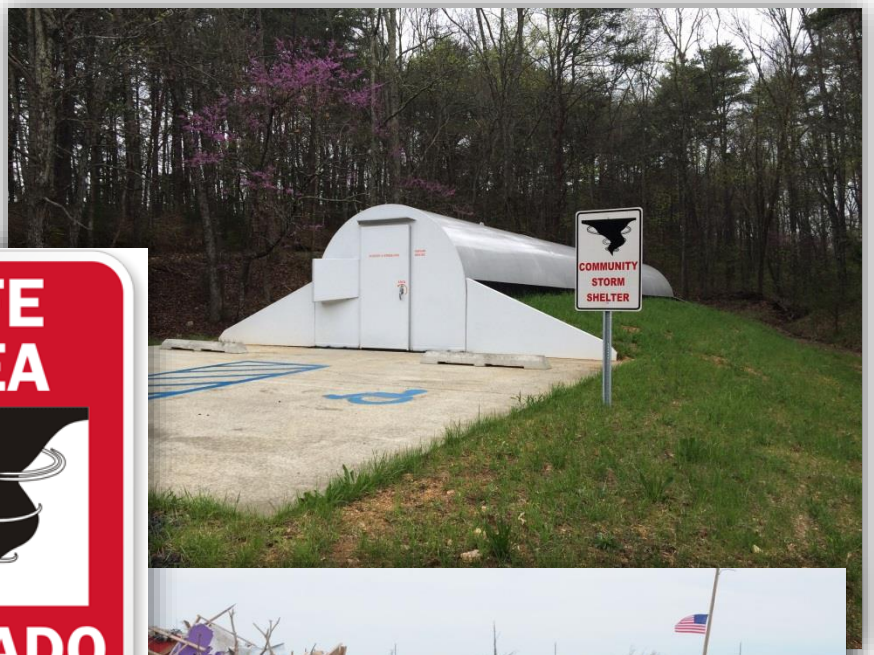

Do You Really Know
How Deep the Water is?
12 inches of fast-moving water can carry away a small car.
WHEN FLOODED TURN AROUND DON'T DROWN
18-24 inches of fast-moving water can carry away most large SUVs, vans and trucks.
6 inches of fast-moving water can knock over and carry away an adult.
NOAA

PLAY VIDEO

Stay weather aware!

- **At home:**
  - Shelter in interior room on bottom floor (no windows)
  - *(mobile home)* get out and take shelter in a sturdy building or storm shelter
- **At work, school:**
  - Move to your safe place (interior room, bottom floor), avoid large open rooms
- **Outside:** Seek shelter in a sturdy building
- **In a vehicle:** Try to make it to a safe place. If unable, get down in car and cover head, or shelter in a low-lying area like a ditch and cover your head

Sheltering from the Storm



Halftime!
10-minute Break
Next, the Goods: Thunderstorm and Tornado Imagery!

Spotter Training Agenda

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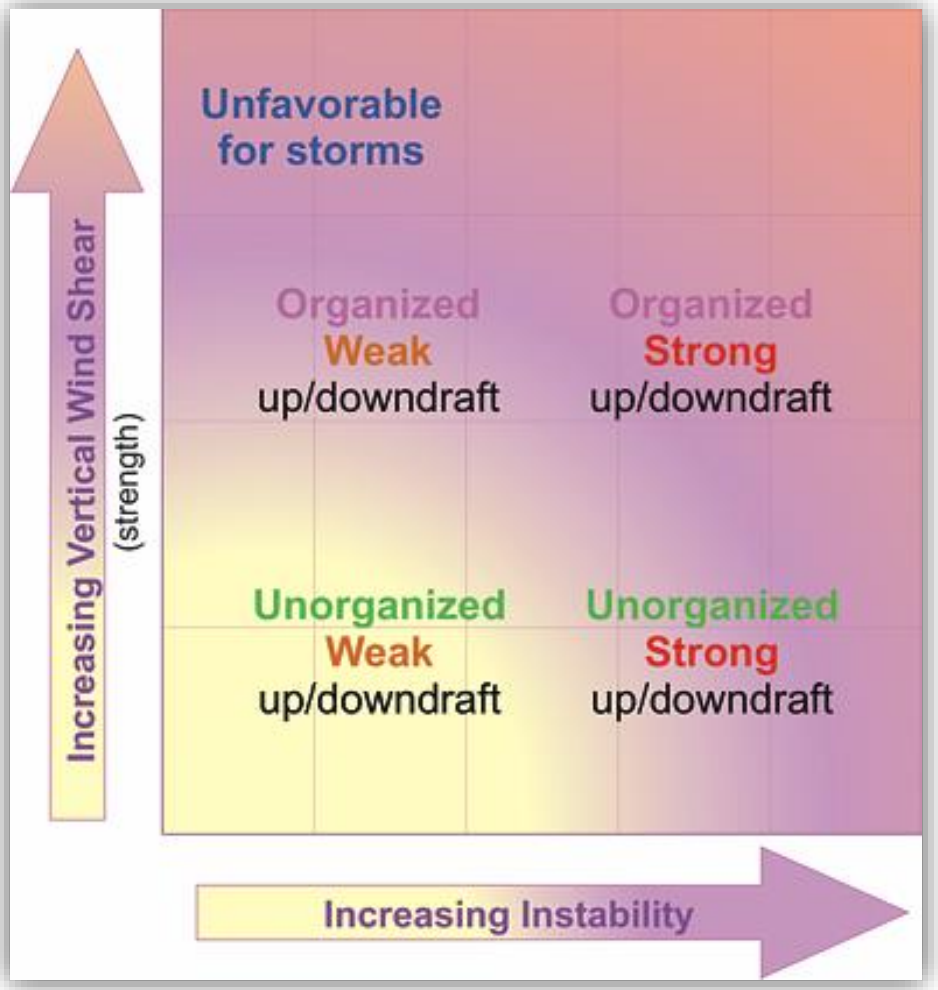
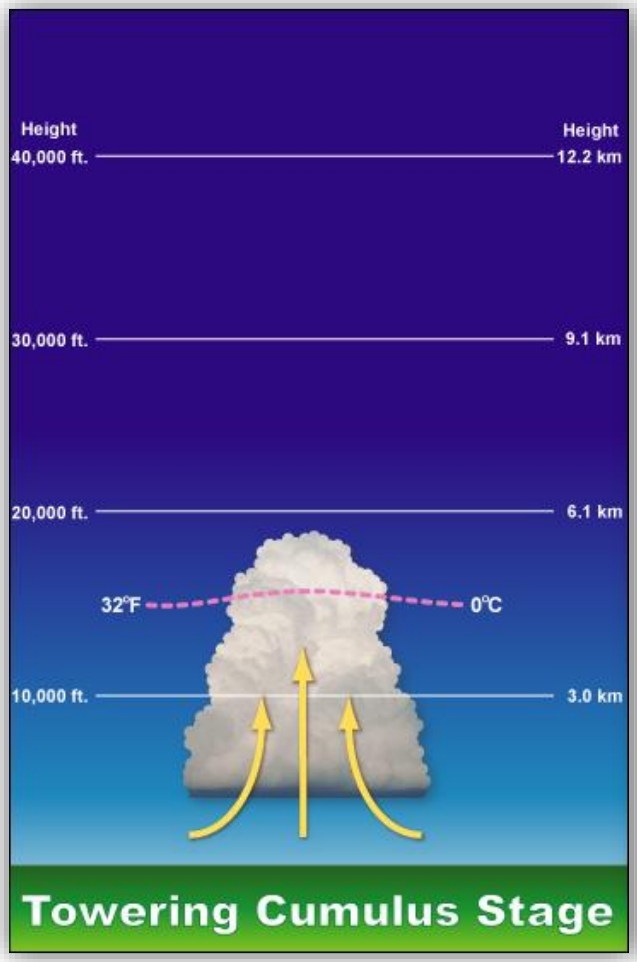
Ingredients for Thunderstorm Formation

- Lift
  - Cold front
  - Warm front
  - Gust front, outflow boundary
  - Terrain (upslope flow)
  - Surface heating
- Moisture
- Instability

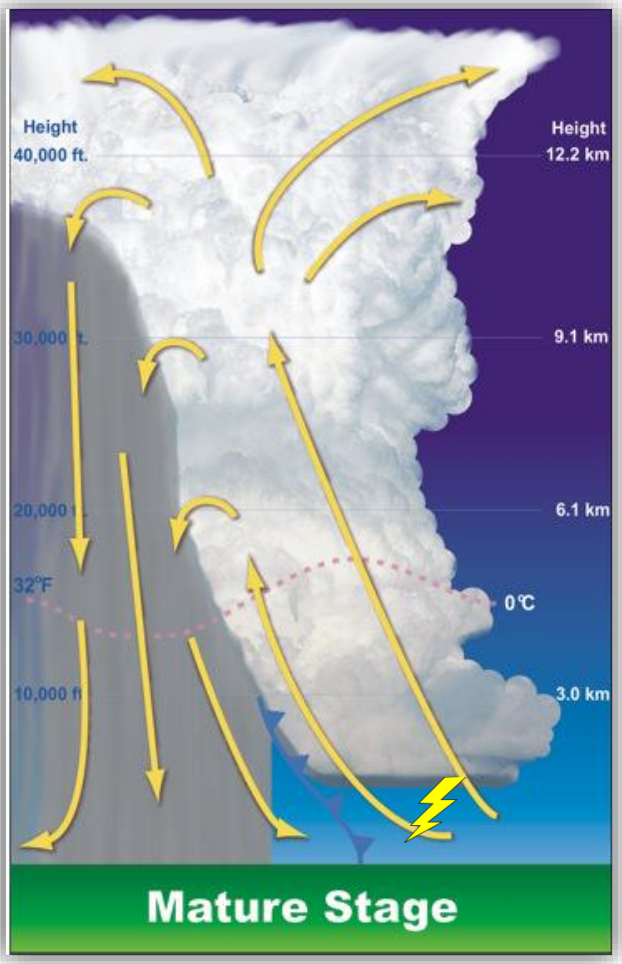


*Wind Shear helps with thunderstorm organization/longevity and severity

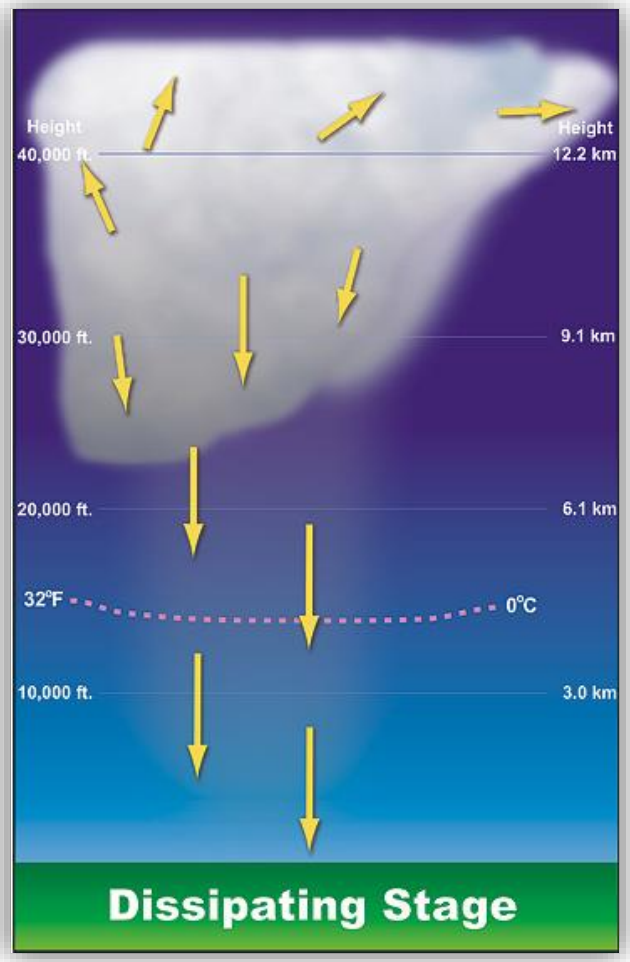
Thunderstorm Stages



- Updraft dominates
- Cumulus cloud grows vertically
-Up to ~20,000 feet tall



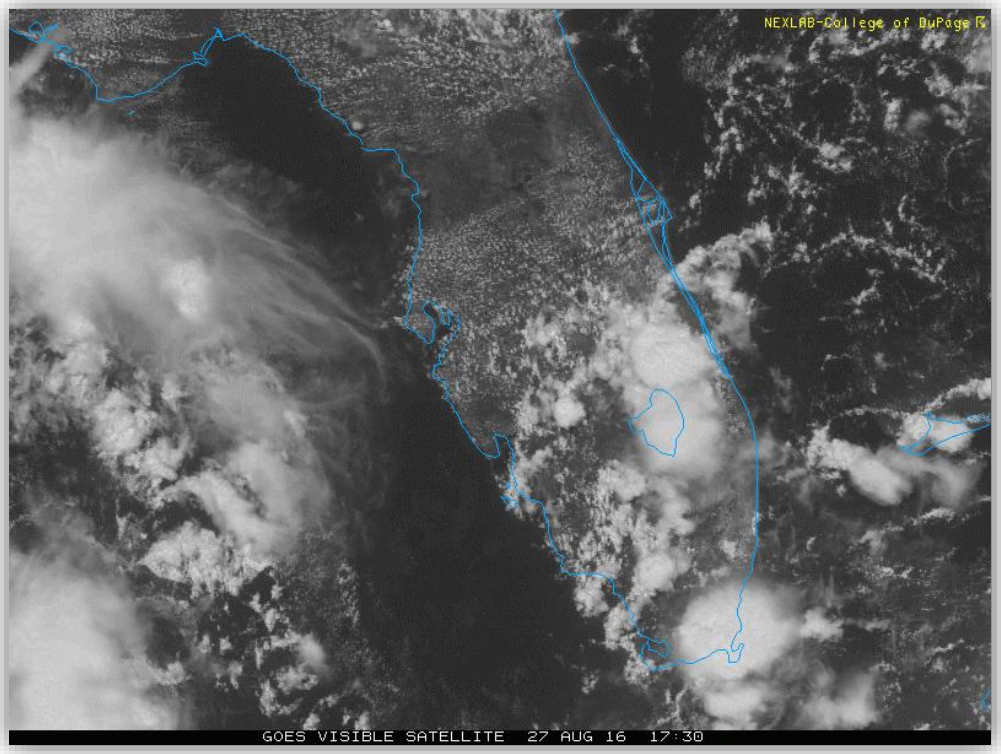
- ~40,000 to 60,000 feet tall
- Strong updraft and downdraft coexist
- Large hail, damaging winds, tornado(es), and flooding rain may occur



- Downdraft cuts off updraft
- Rain, gusty winds, and last lightning strike
- Remnant anvil cloud aloft

Thunderstorm Types

- Single cell
- Multicell
  - Cluster
  - Line
- Supercell
  - Classic
  - Low-precipitation (LP)
  - High-precipitation (HP)
- Mini-supercell

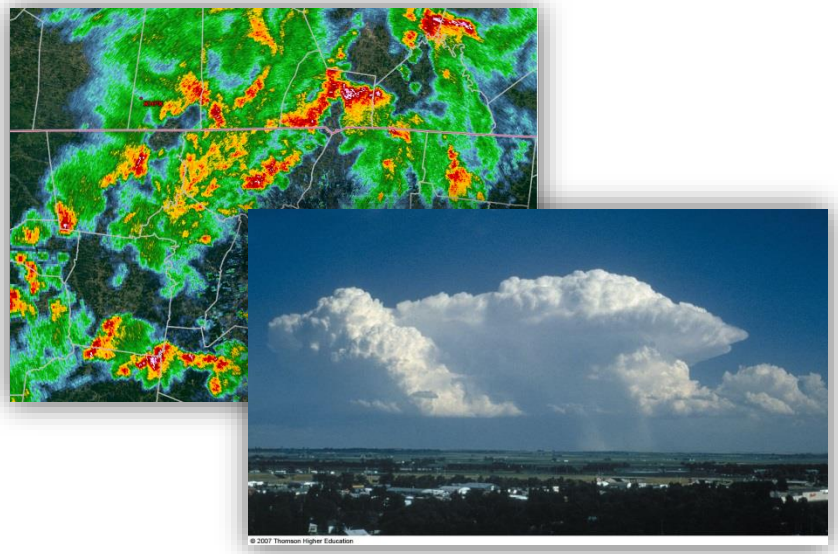


Thunderstorm Types – Single Cell (pulse thunderstorm)

Emphasis: we are talking about pulse thunderstorms, not single cell to include supercell storms!

- **Rather short-lived**
- **Can be randomized in location**
- **No or low severe weather threat**

Thunderstorm Types - Multicell



Multicell Cluster

- Low severe weather threat
- Several storm cells in a clump, but each in a different stage of the thunderstorm lifecycle
- Cells 'take turns' at being most dominant
- Gusty, sometimes damaging winds; hail

Multicell Line (squall line)

- Moderate to high severe weather threat (depending on the environment)
- Several storm cells form a line along the leading edge of the system
- Moderately gusty winds to widespread damaging winds (depending on the environment)
- Weak to strong tornadoes (depending on the environment)

Thunderstorm Types - Supercell

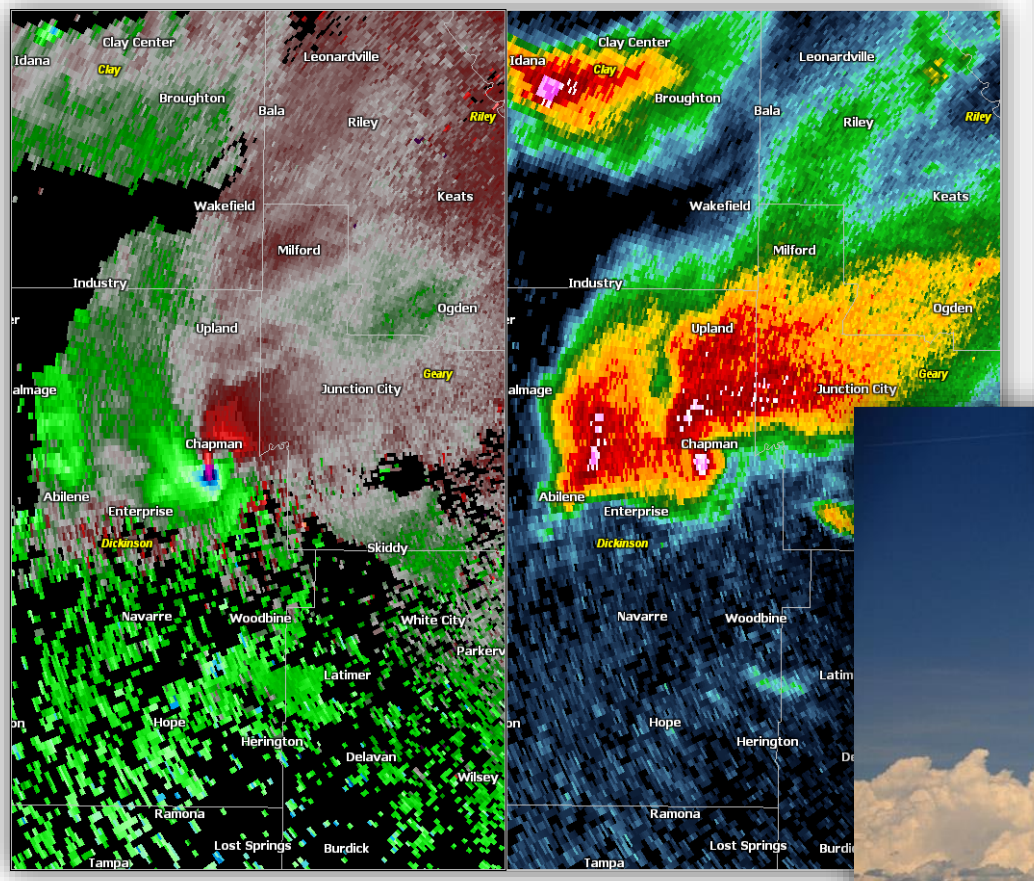
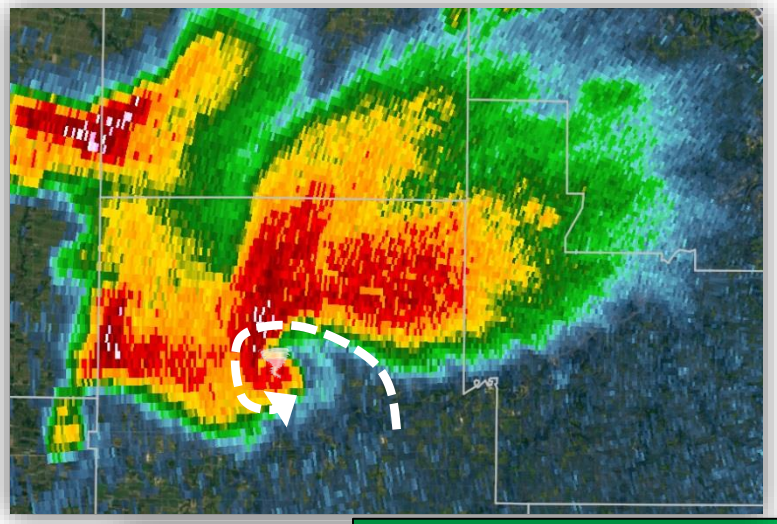
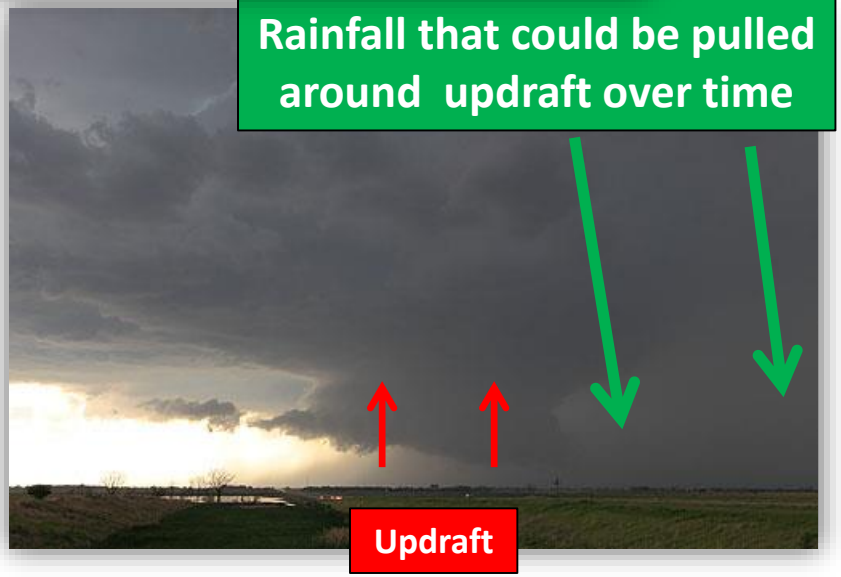


Image Courtesy: Noah Brauer

Thunderstorm Types – Supercell (Classic)

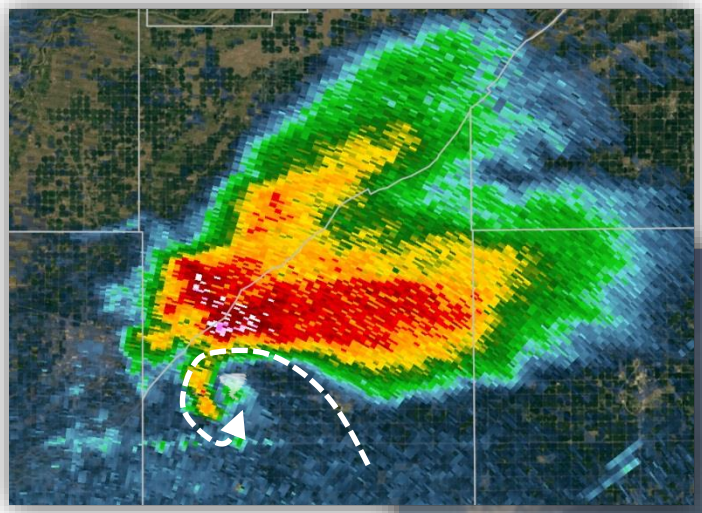
- Rotating and visible updraft; however, heavy rain can eventually be pulled around the updraft, obscuring it
- High severe weather threat
  - Large to very large hail
  - Damaging winds
  - Tornado(es)
  - Flash flooding





Thunderstorm Types – Supercell (Low Precipitation; LP)

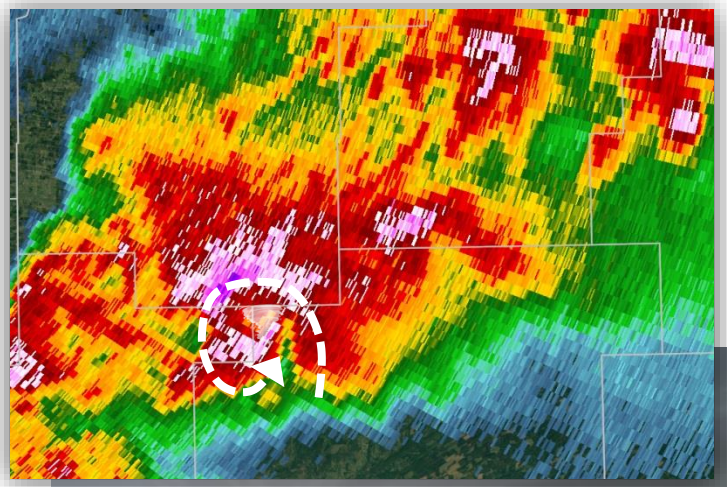
- Rotating updraft often with no or very little rain in vicinity
- Hook echo may not be visible on radar, or very faint
- Low to high severe weather threat (depends on the environment)
  - Large to very large hail
  - Damaging winds
  - Tornado(es)
- Very, very rare for Alabama; more common in drier regions



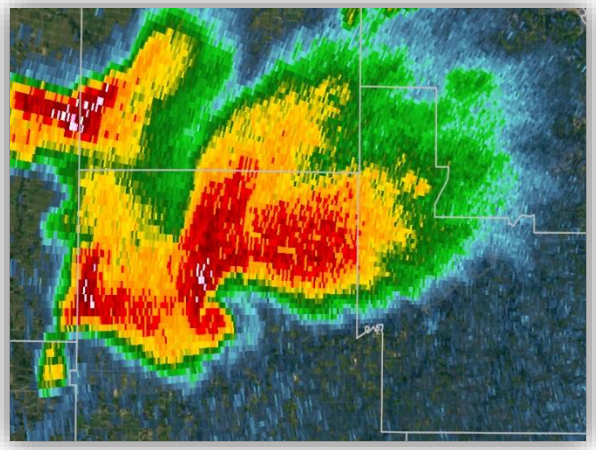
Thunderstorm Types – Supercell (High Precipitation; HP)

- Rotating updraft often obscured by heavy rainfall (and sometimes hail)
  - Therefore the tornado will be very hard or impossible to see!

- High severe weather threat
  - Large to very large hail
  - Damaging winds
  - Tornado(es)
  - Flash flooding

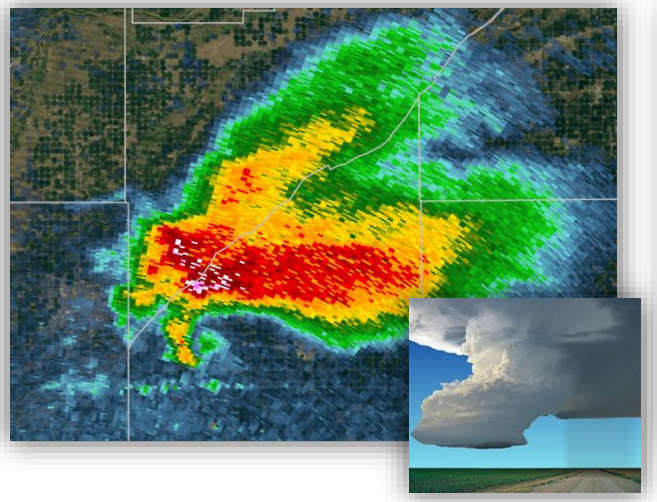


Supercell Type Recap



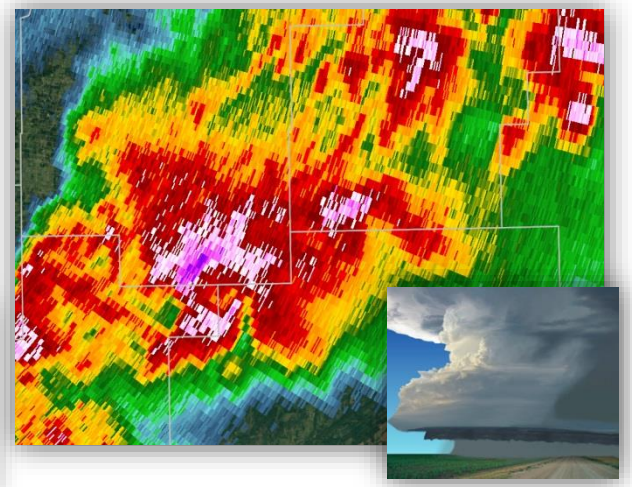
Classic

>> Updraft (and tornado if occurring) visible, but could become rain-wrapped with time



Low Precipitation (LP)

>> Updraft (and tornado if occurring) highly visible

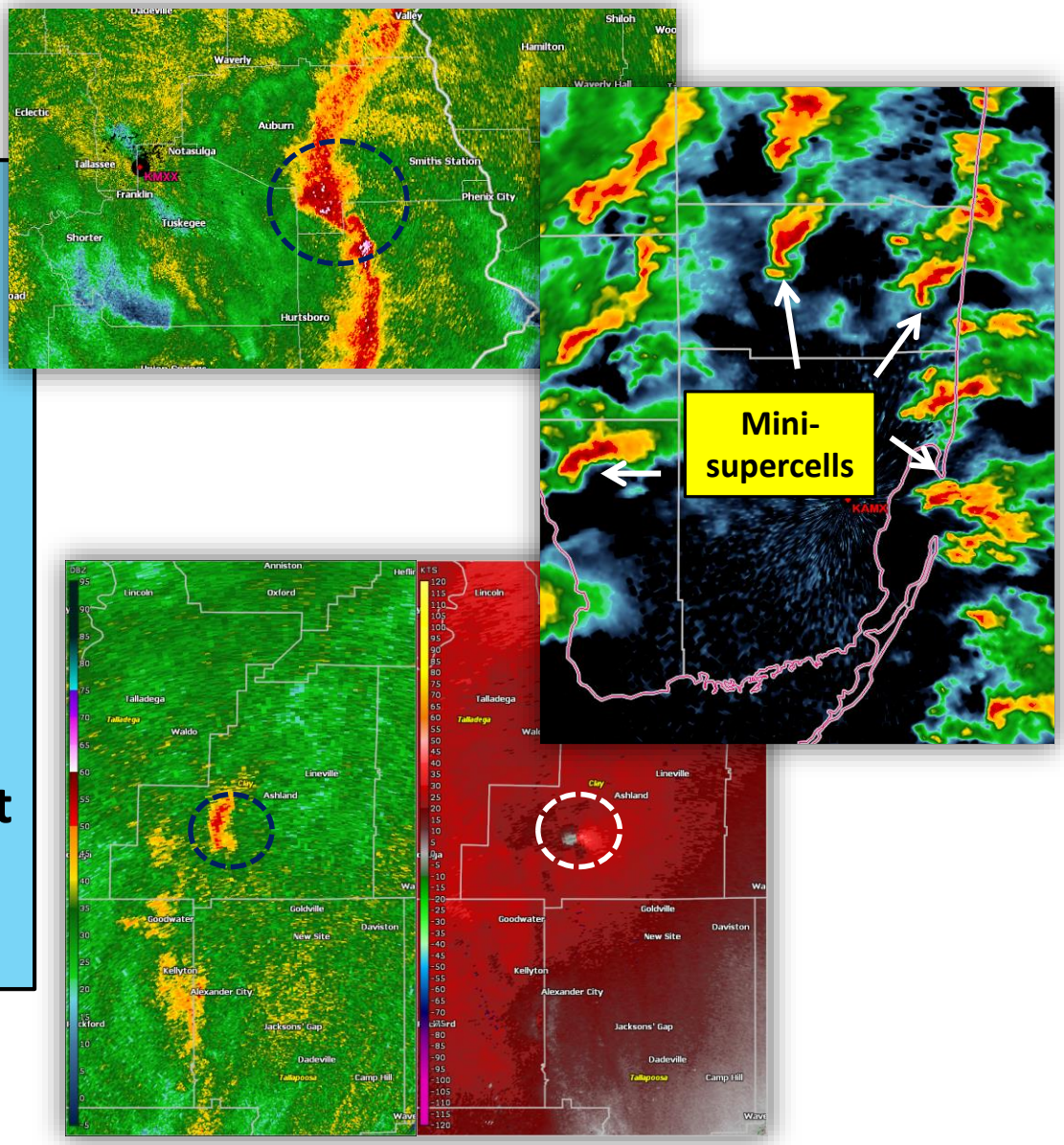


High Precipitation (HP)

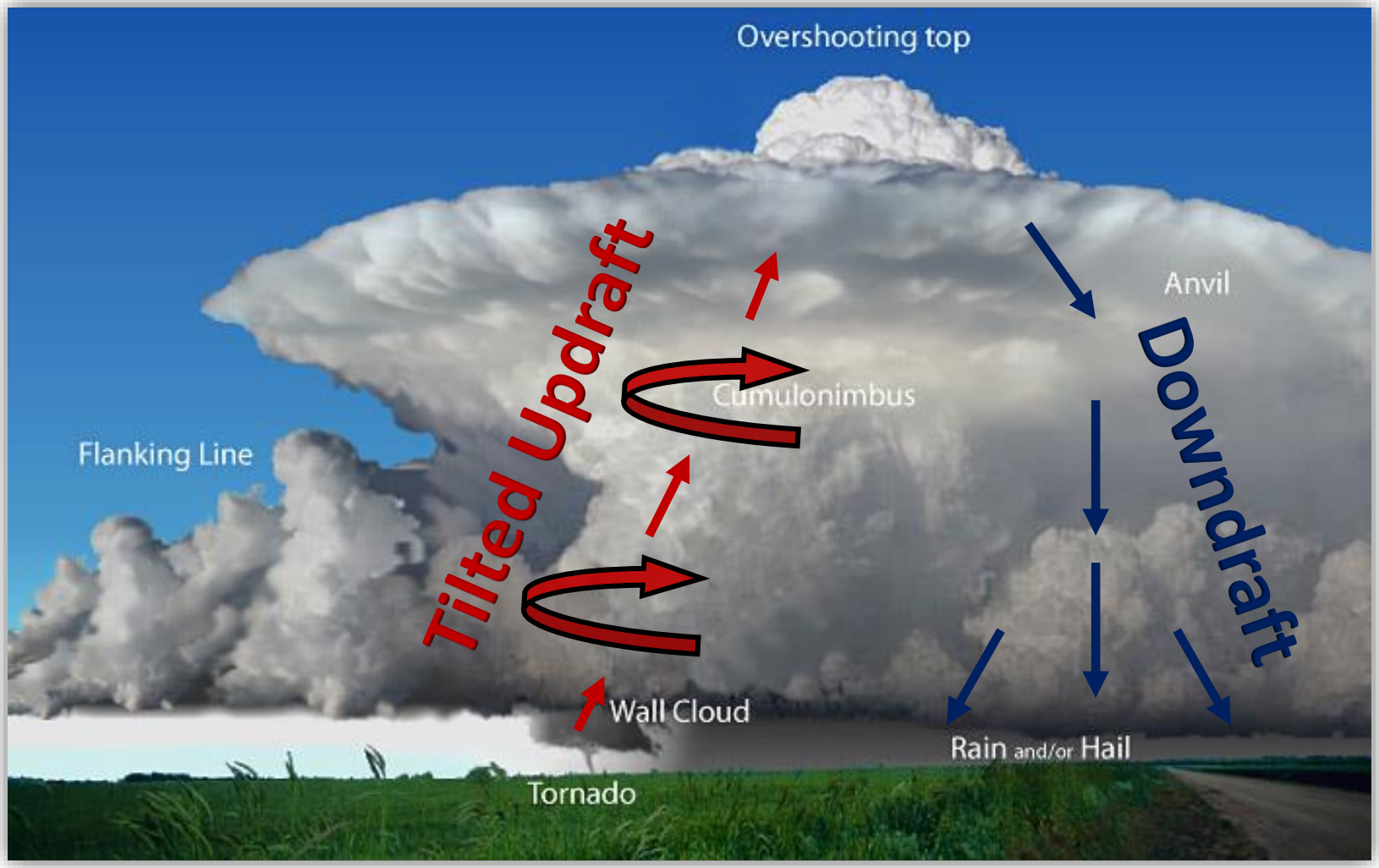
>> Updraft (and tornado if occurring) are rain-wrapped

Mini-Supercell

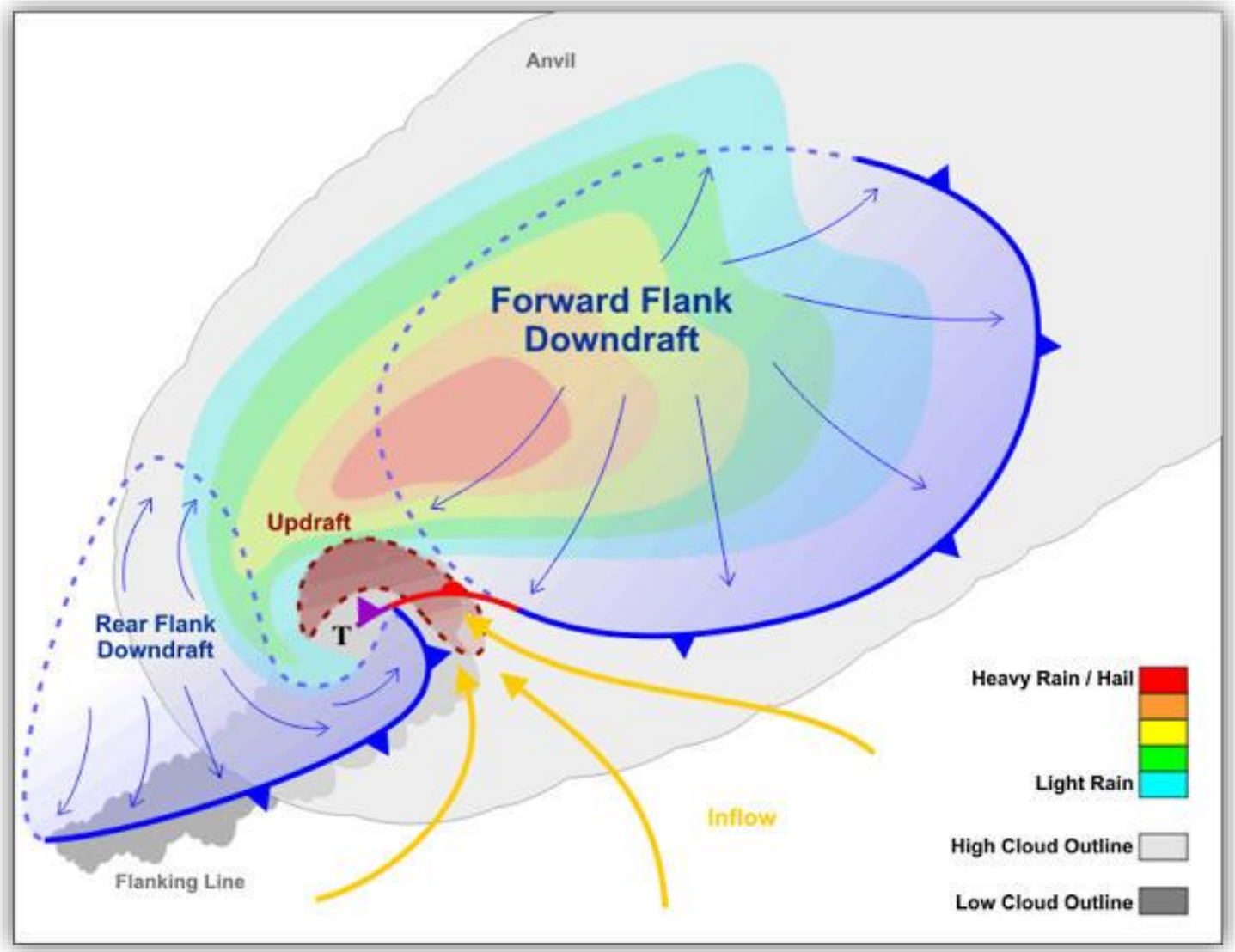
- A small, shallow storm with a rotating updraft
- Can be within a large shield of rain, a line of storms, or discrete
- Severe threat not as 'significant' as their counterparts
  - Low wind and hail threat
  - Can produce a brief, weak tornado(es)



Supercell Thunderstorm Structure

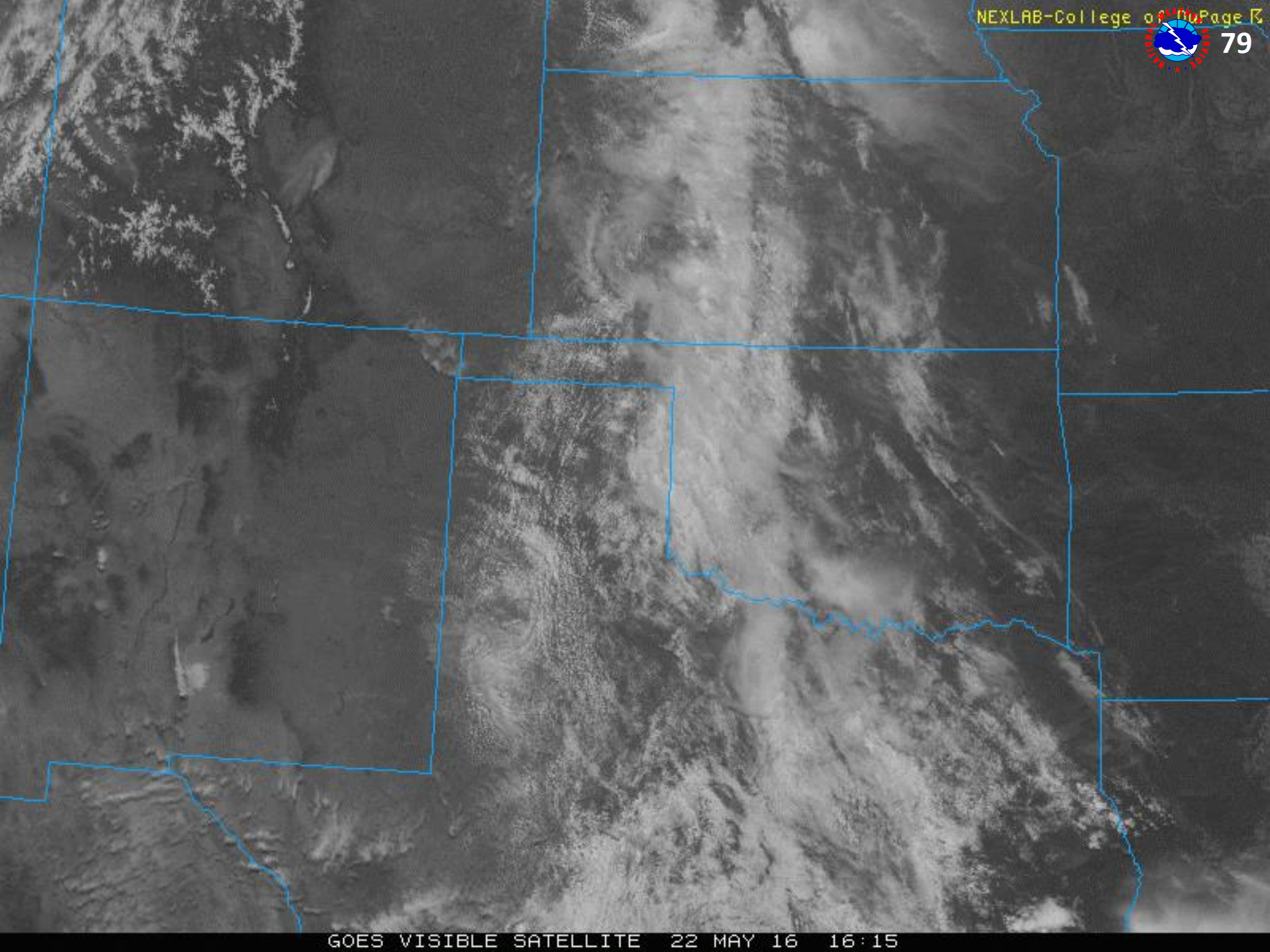


Supercell Thunderstorm Structure



Credit: Dr. Leigh Orf (UW, CIMSS)

Supercell Structure Real-world Showcase


NEXLAB-College of DuPage
79
GOES VISIBLE SATELLITE 22 MAY 16 16:15

Spotter Training Agenda

Part I

- Who we are, and why we need spotters?
- Severe weather definitions
- What and how to report
- Safety in storm spotting

--Break--

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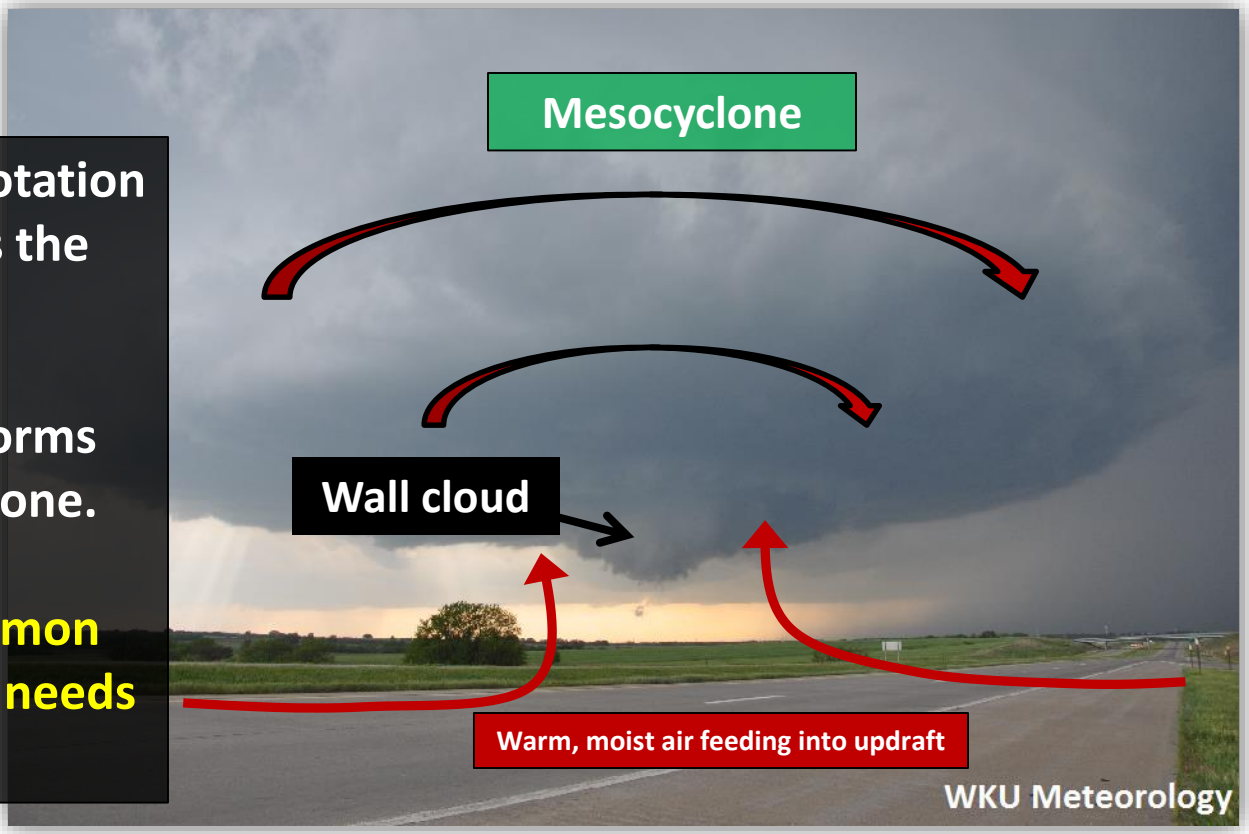
Mesocyclone – Region of Rotation and Inflow Winds

Storm-scale area of deep, rotation (counter-clockwise) -- It's the parent circulation.

Wall cloud and tornado forms underneath the mesocyclone.

Don't confuse with a common rain-free base. The updraft needs to be rotating!



Mesocyclone– Characteristics

- A storm-scale region of rotation, typically 2-6 miles in diameter
- The circulation of a mesocyclone covers an area much lager than the wall cloud or tornado that may develop underneath it
- Striations appear on strong, well-developed mesocyclones

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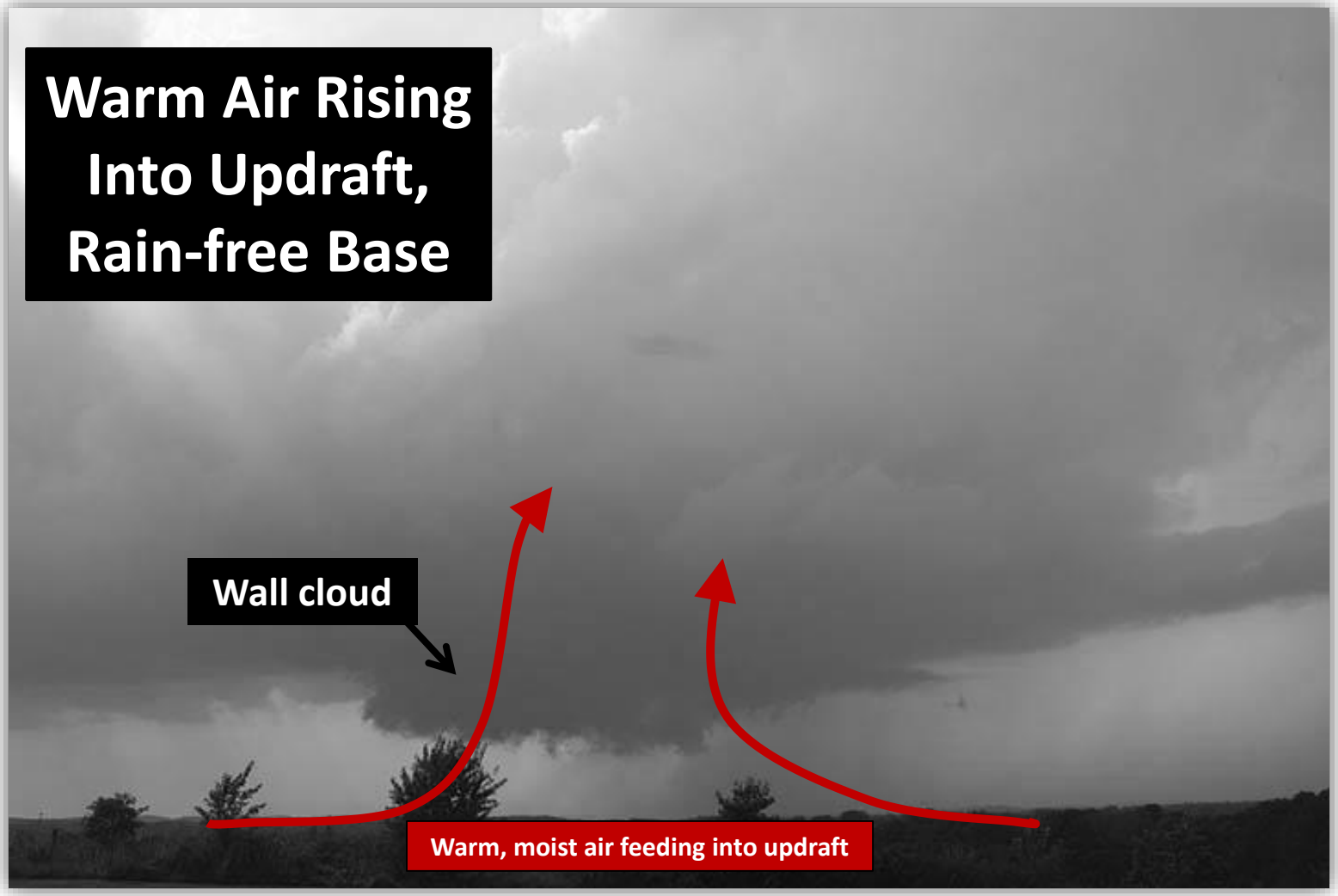
Wall Cloud – Inflow Winds Located Underneath the Mesocyclone



Wall Cloud – Characteristics

- Surface-based inflow under the updraft, mesocyclone
- A localized, persistent and attached lowering of the cloud from the storm's rain-free base
- Normally found on the south or southwest (inflow) side of the thunderstorm
- May exhibit rapid, upward and downward motion as well as rotation; however, **not all wall clouds rotate**
- Often slopes or points **toward** precipitation or downdraft area
- Most do not produce a tornado

Shelf Cloud – Outflow Winds

Shelf Cloud – Characteristics

- Marks the leading edge of the gust front
- Usually produced by rain-cooled air
- Usually in an area of low-level shear
- Slopes away from precipitation area
- Often associated with a squall line and is typically associated with damaging, straight-line wind
- You will often see many turbulent eddies on the edge of, or underneath, the shelf cloud. This turbulent motion is not associated with anything tornadic!

Wall Cloud vs. Shelf Cloud Recap

Very Important!

	Wall Cloud	Shelf Cloud
Associated with the Updraft	✓	✗
Associated with the Downdraft	✗	✓
Often slopes toward the rain (downdraft)	✓	✗
Slopes down away from the rain (downdraft)	✗	✓
Often associated with funnel clouds and tornado	✓	✗
Favored area for rotation	✓	✗

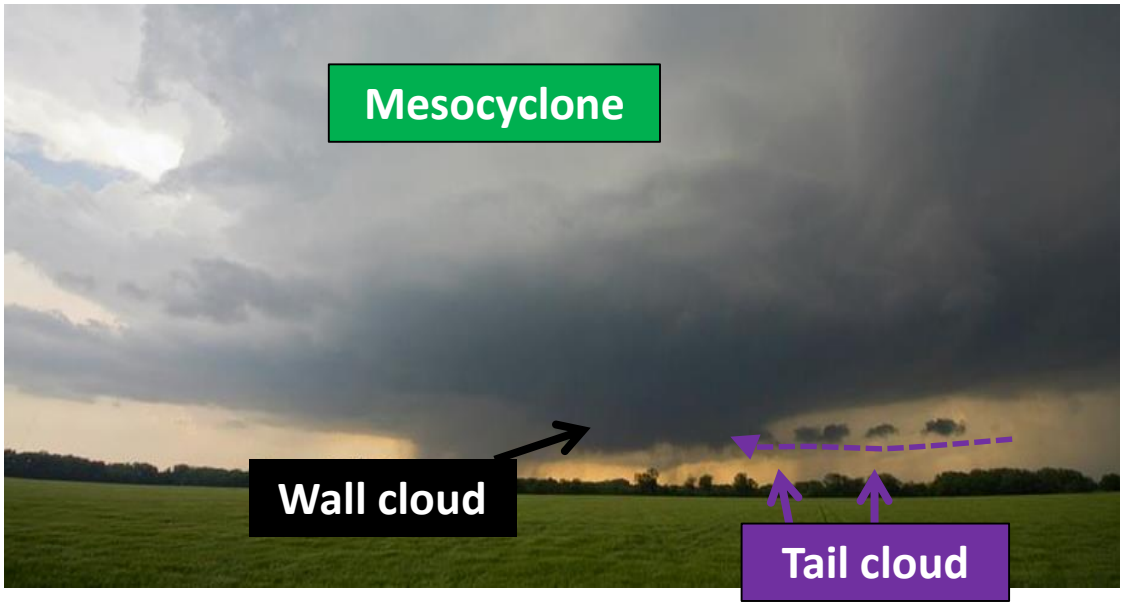
Scud Clouds: Tornado Look-Alikes

- Cloud fragments that are unattached, or rising into the storm's base
- **They do not rotate; thus, not a funnel cloud, not a tornado – harmless!**

Depending on the situation, rising scud clouds can organize to form a wall cloud at the storm's base. In this case, watch for further development and rotation.

Tail Cloud – Inflow Winds

Tail Cloud = inflow feeding into the wall cloud



Some of these inflow bands may develop quite close to the ground

Don't get tricked – not a Funnel Cloud, not Tornado!

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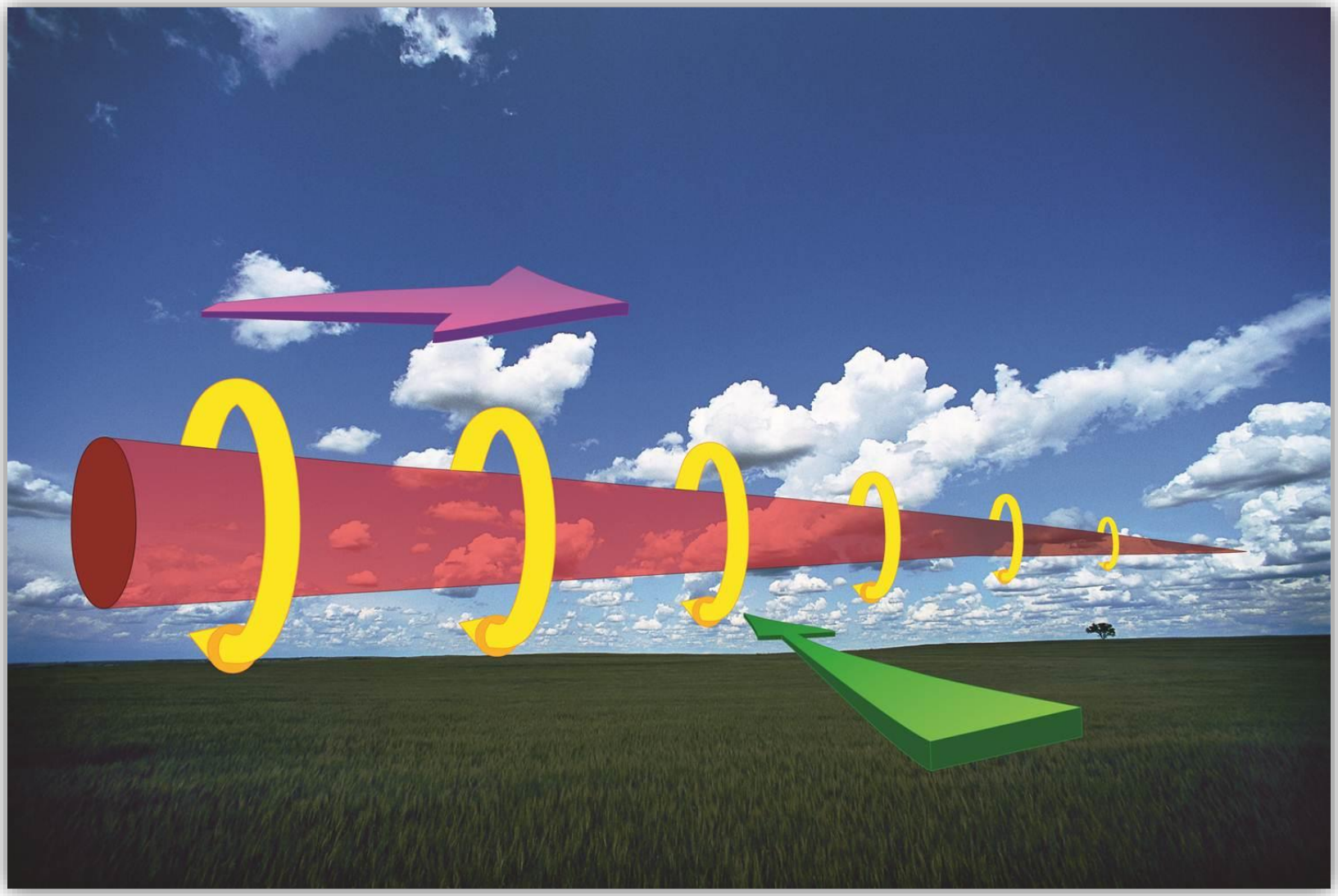
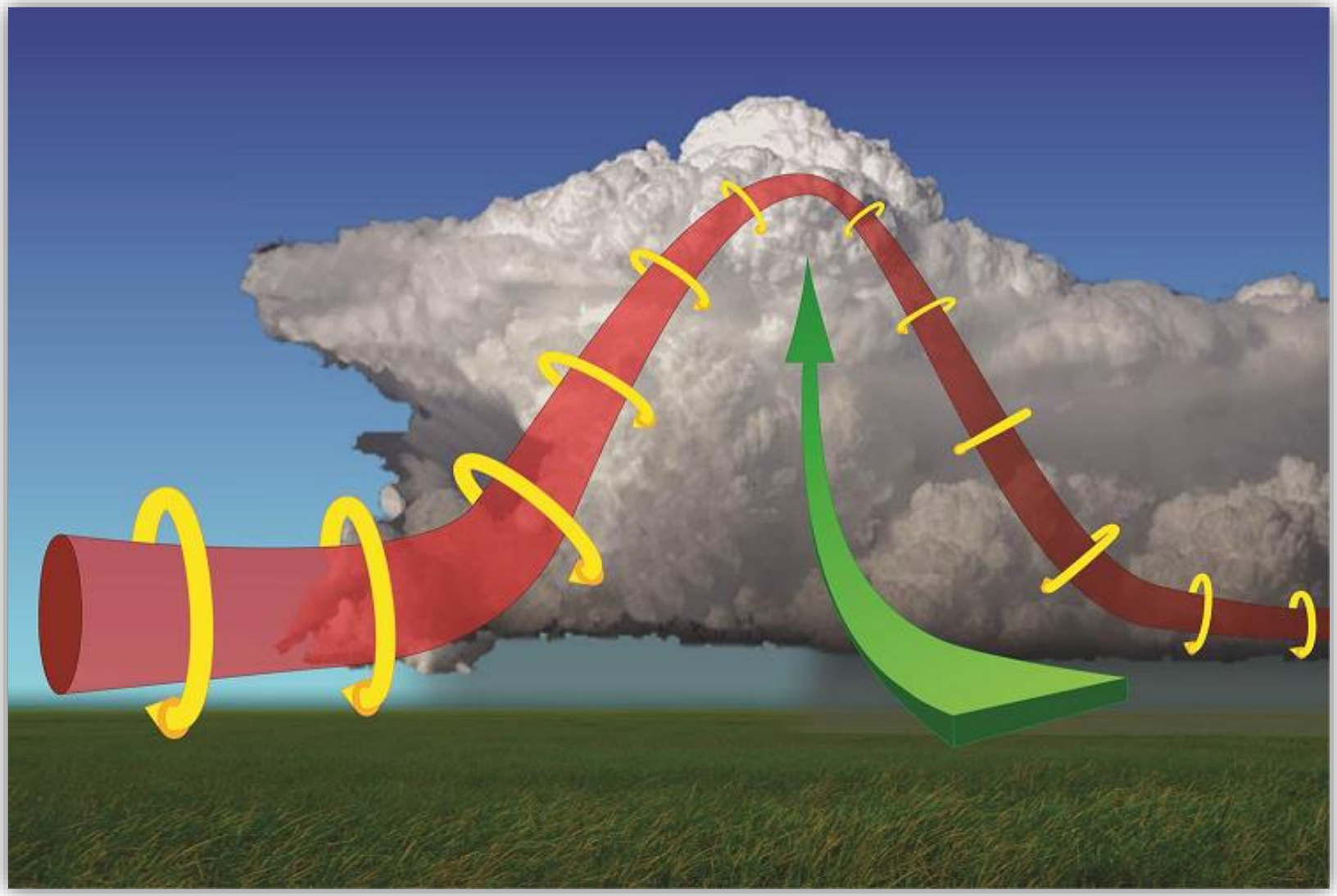
Tornado Formation I



Tornado Formation II



Tornado Formation III

Funnel Cloud Develops

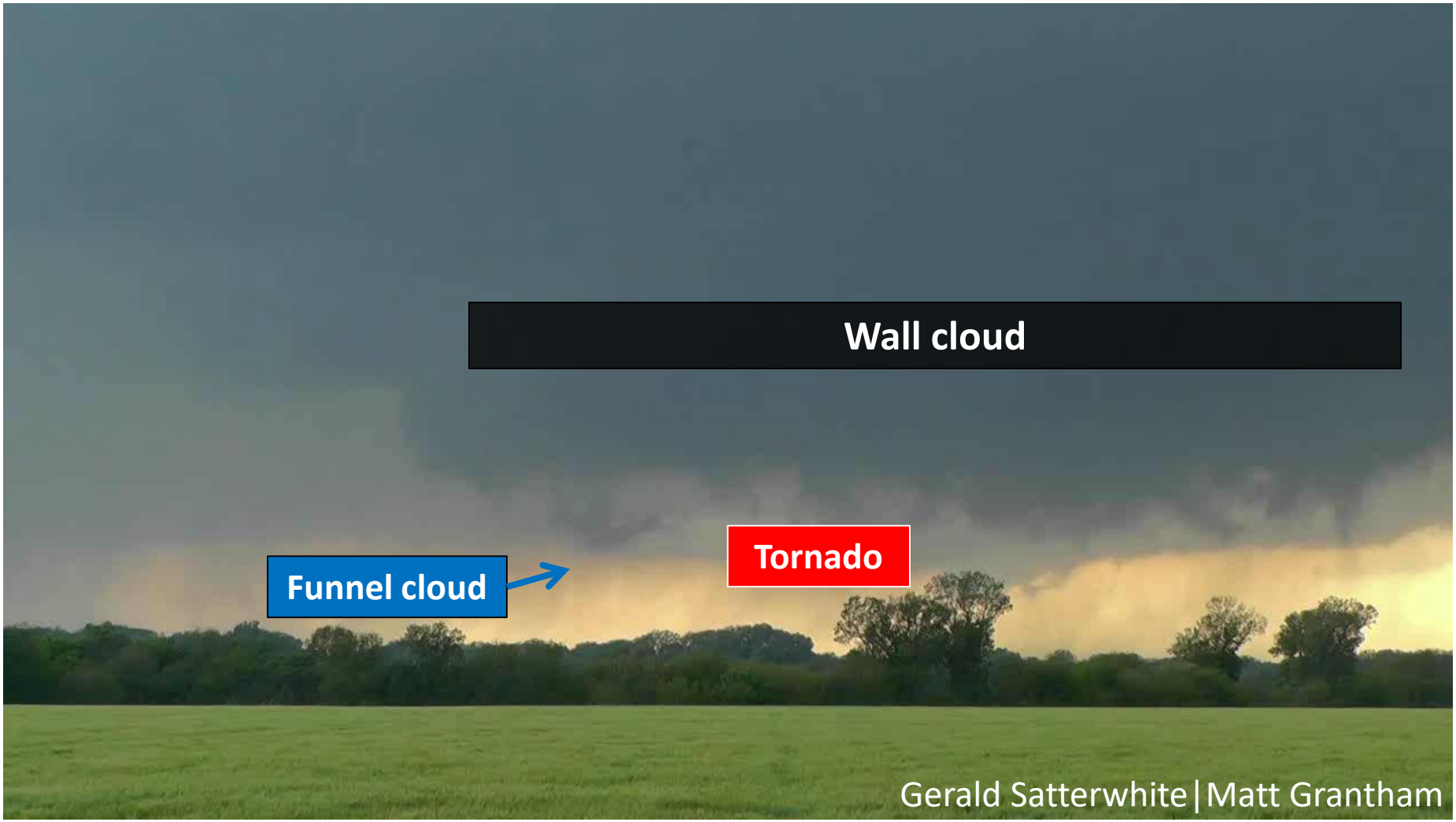
- A **rotating**, funnel-shaped cloud extending downward from a thunderstorm base
- Most often laminar or smooth in appearance
- Usually located near the updraft
- Attached to cloud base
- **Funnel clouds do not reach the ground!**

Then (maybe), Tornado!

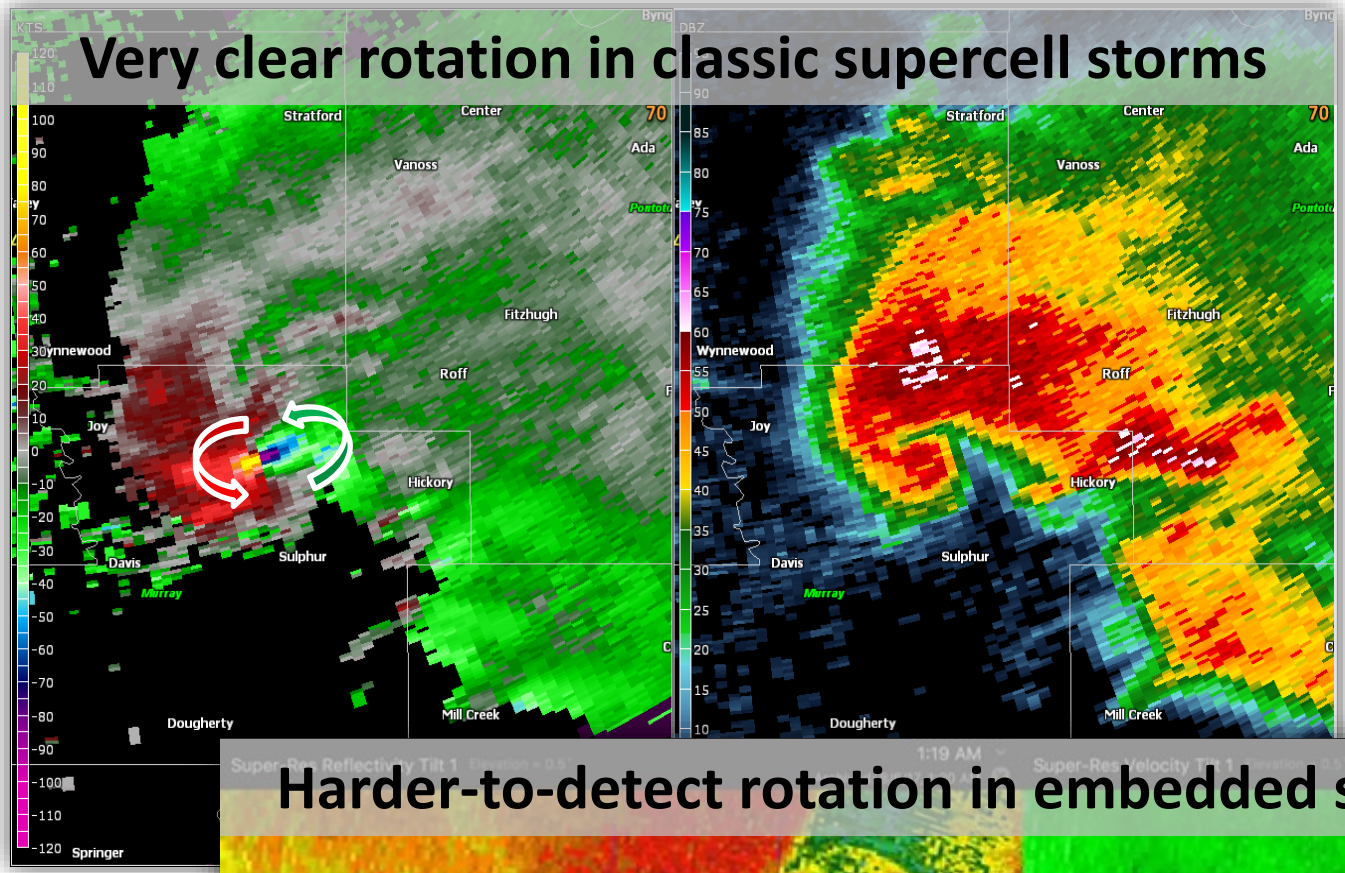
- A violently-rotating column of air extending from cloud base **to the ground**
- The condensation cloud (part of the tornado, funnel you can see) may not extend all the way to the ground, but any debris kicked up along the ground indicates contact!

Wall Cloud -> Tornado Evolution

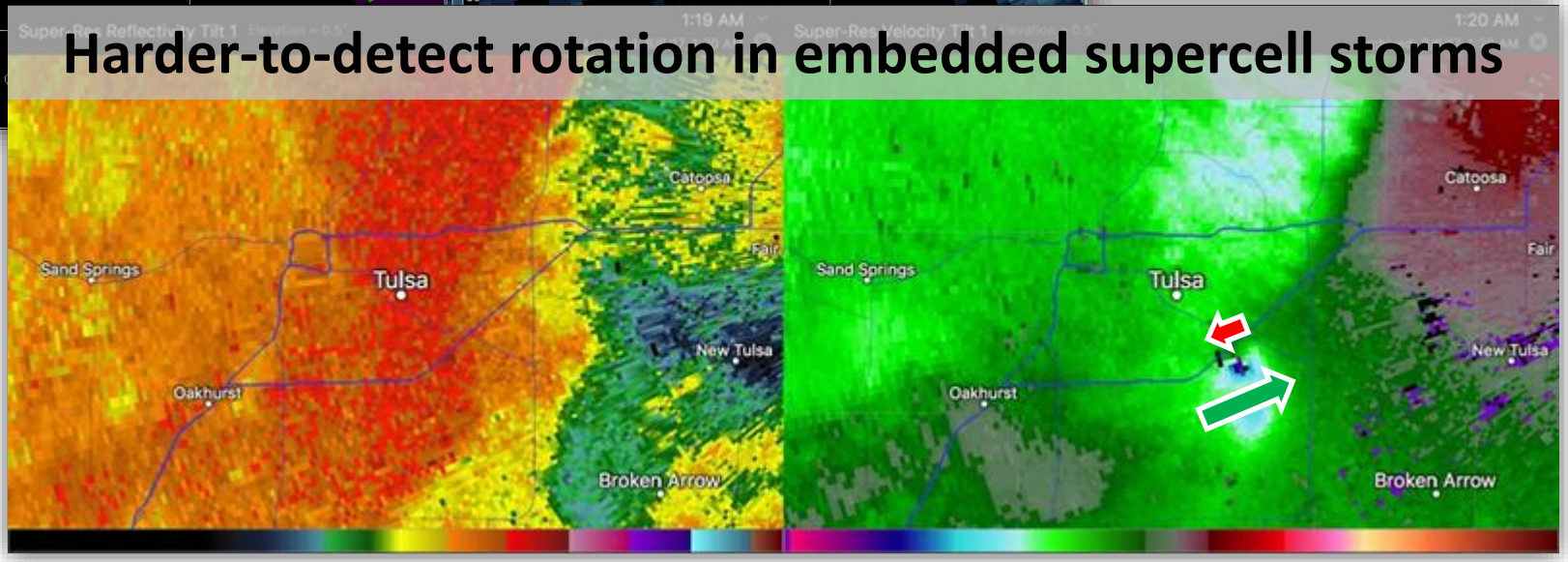
3-minute Wall Cloud -> Funnel Cloud -> Tornado Video Evolution



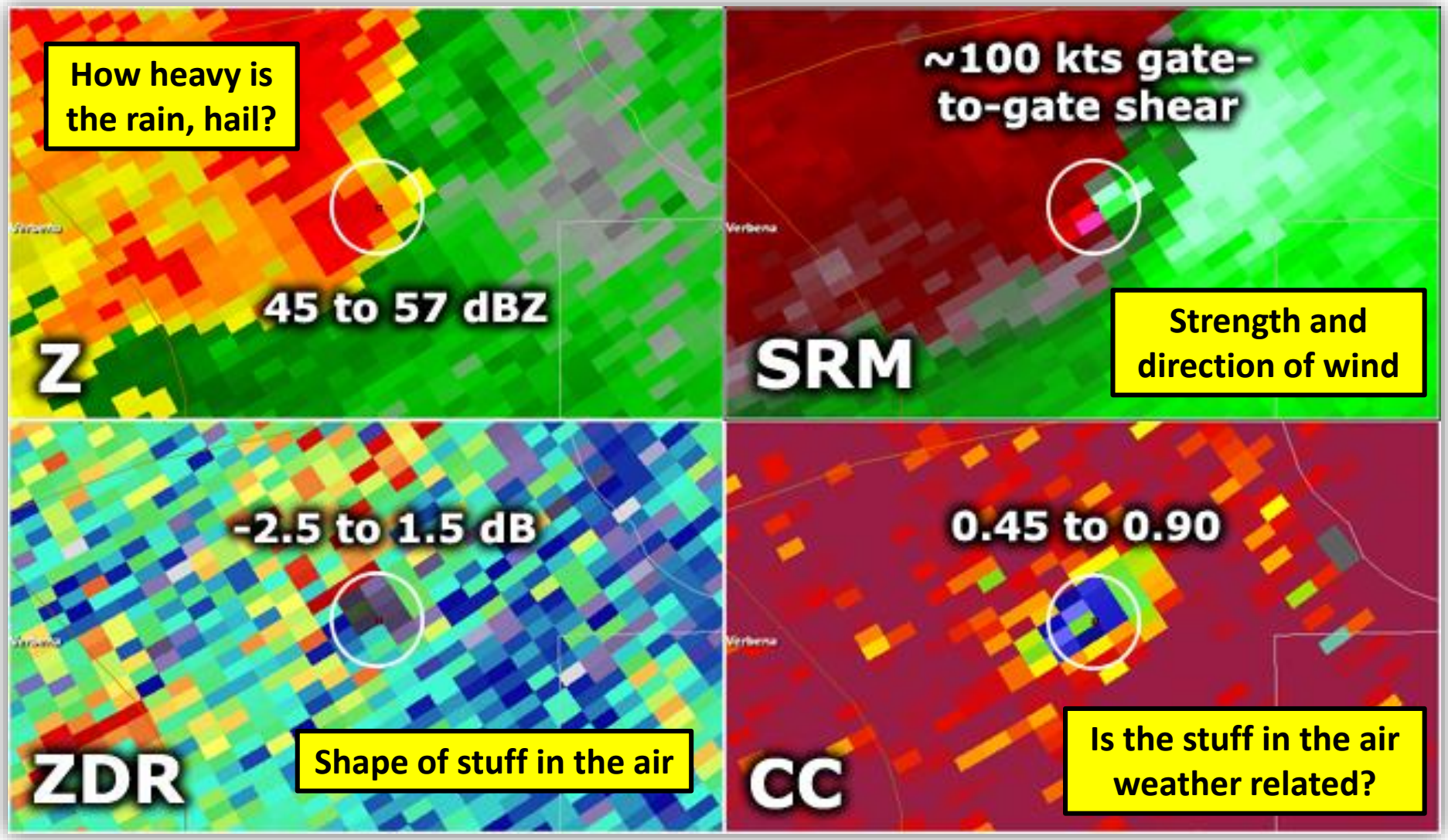
Very clear rotation in classic supercell storms



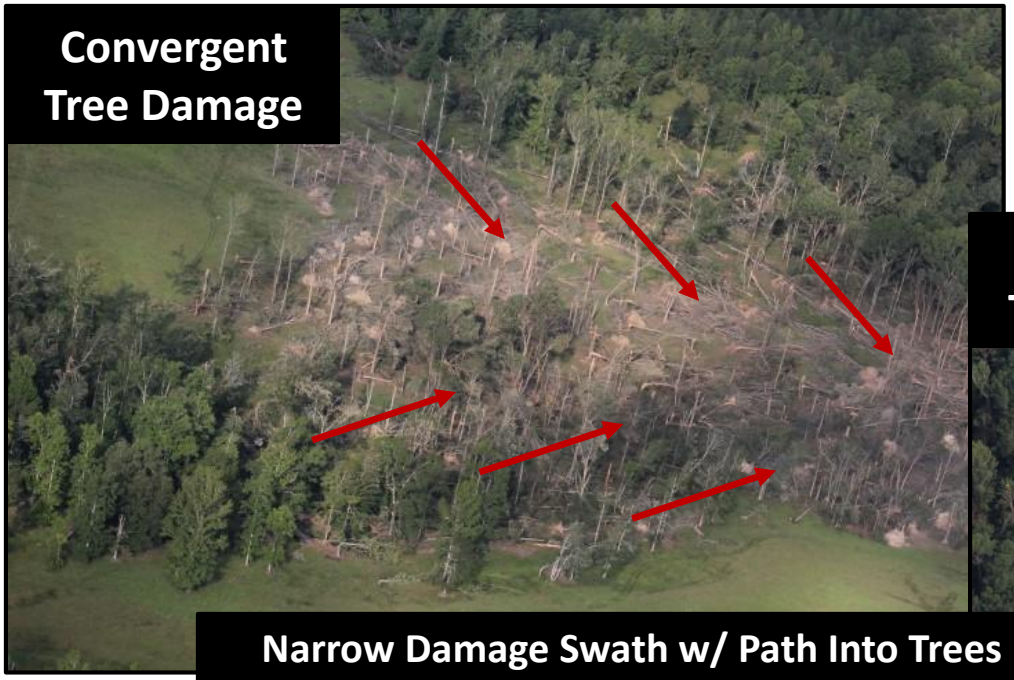
Harder-to-detect rotation in embedded supercell storms



We can now spot tornado debris on radar!



Tornado Damage Pattern



EF Rating	Wind Speeds	Expected Damage		
EF-0	65-85 mph	'Minor' damage: shingles blown off or parts of a roof peeled off, damage to gutters/siding, branches broken off trees, shallow rooted trees toppled.		
EF-1	86-110 mph	'Moderate' damage: more significant roof damage, windows broken, exterior doors damaged or lost, mobile homes overturned or badly damaged.		
EF-2	111-135 mph	'Considerable' damage: roofs torn off well constructed homes, homes shifted off their foundation, mobile homes completely destroyed, large trees snapped or uprooted, cars can be tossed.		
EF-3	136-165 mph	'Severe' damage: entire stories of well constructed homes destroyed, significant damage done to large buildings, homes with weak foundations can be blown away, trees begin to lose their bark.		
EF-4	166-200 mph	'Extreme' damage: Well constructed homes are leveled, cars are thrown significant distances, top story exterior walls of masonry buildings would likely collapse.		
EF-5	> 200 mph	'Massive/incredible' damage: Well constructed homes are swept away, steel-reinforced concrete structures are critically damaged, high-rise buildings sustain severe structural damage, trees are usually completely debarked, stripped of branches and snapped.		

Spotter Training Agenda

Part I

- Who we are, and why we need spotters?
- Severe weather definitions
- What and how to report
- Safety in storm spotting

--Break--

Part II

- Thunderstorm development and thunderstorm types
- Mesocyclone
- Wall Clouds vs. Shelf Clouds; Scud Clouds and Tail Clouds
- Tornado formation
- Report what you see; photo polls
- Spotter information recap

Report what you See!

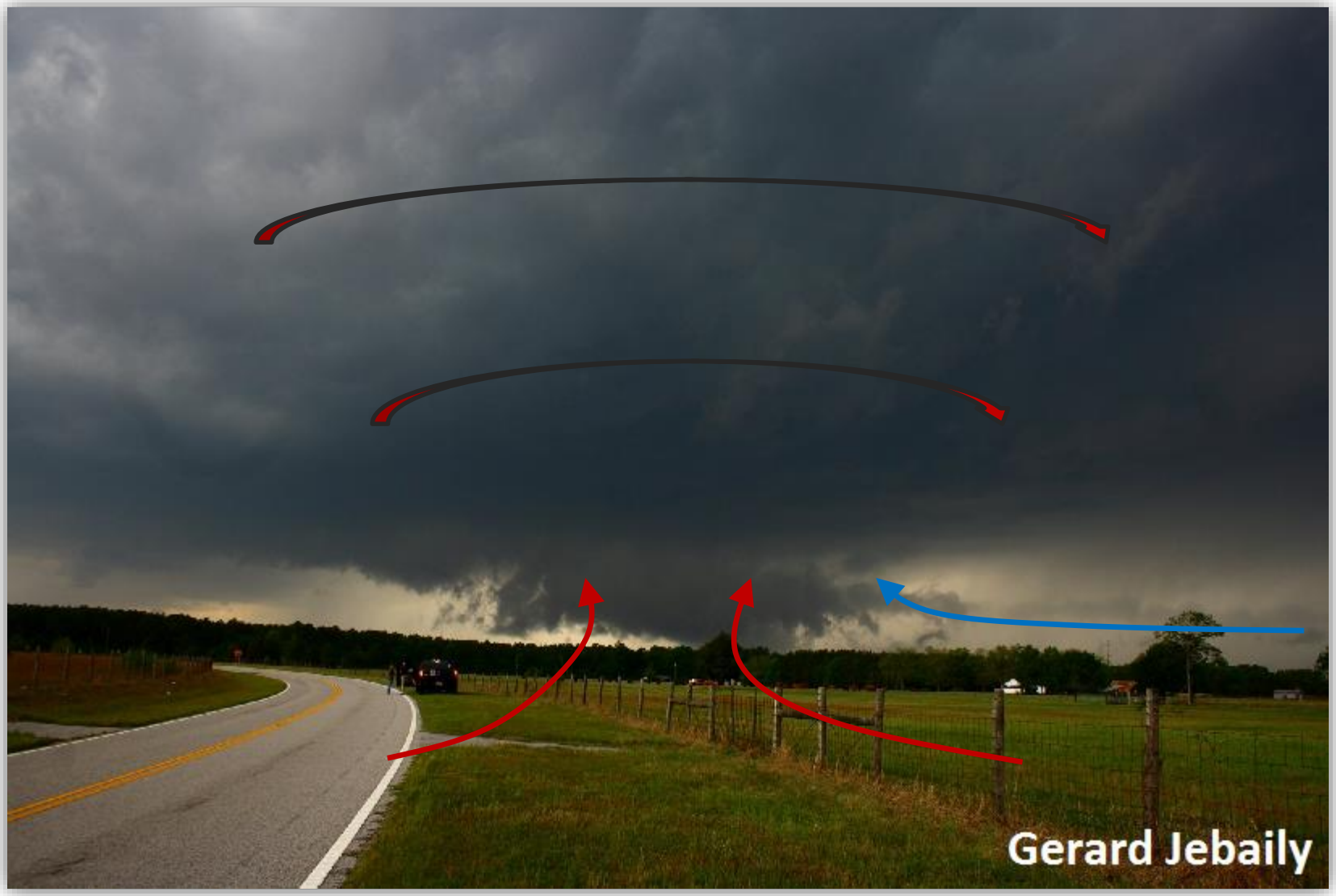
1

Report what you See!

2

Report what you See!

Report what you See!



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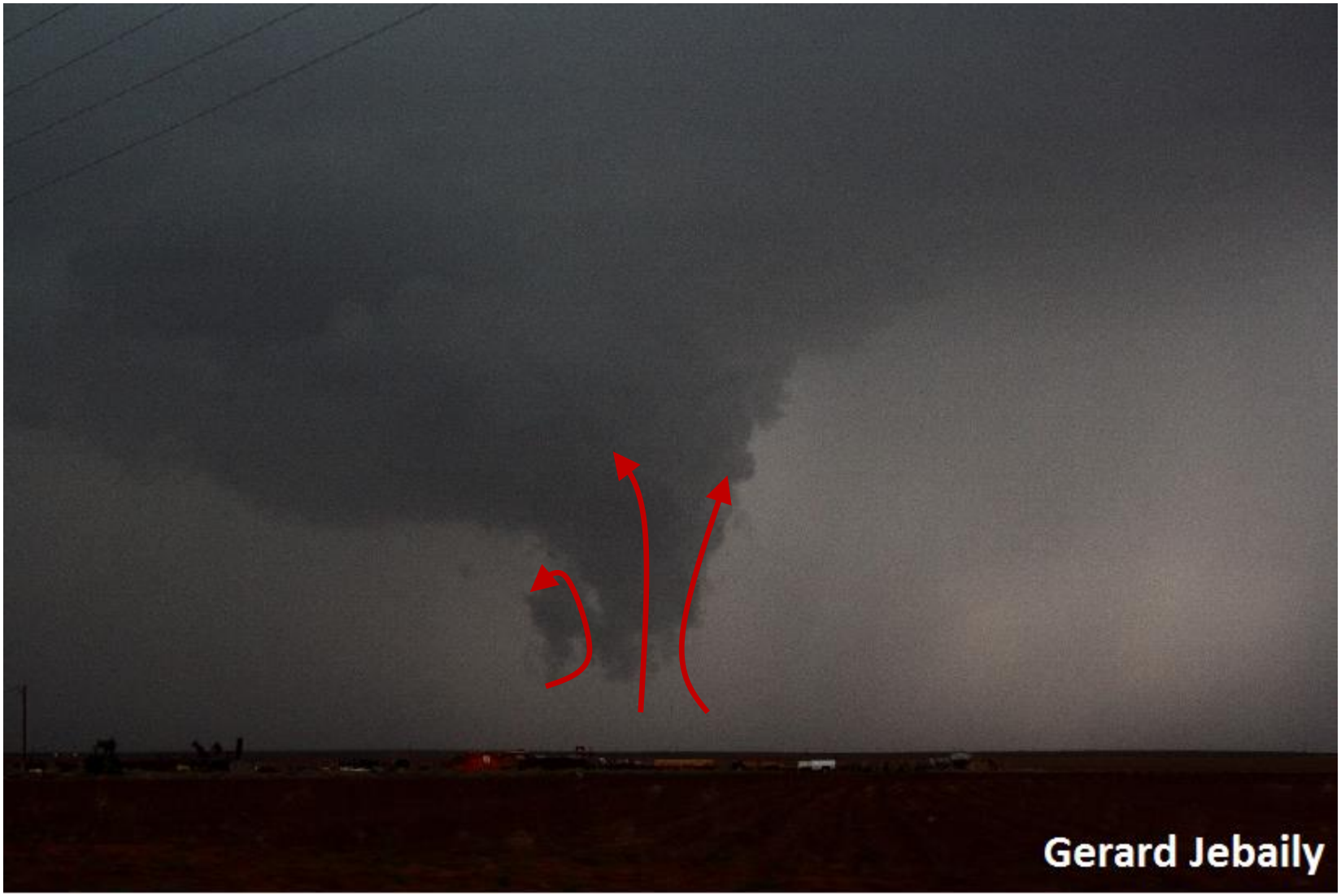

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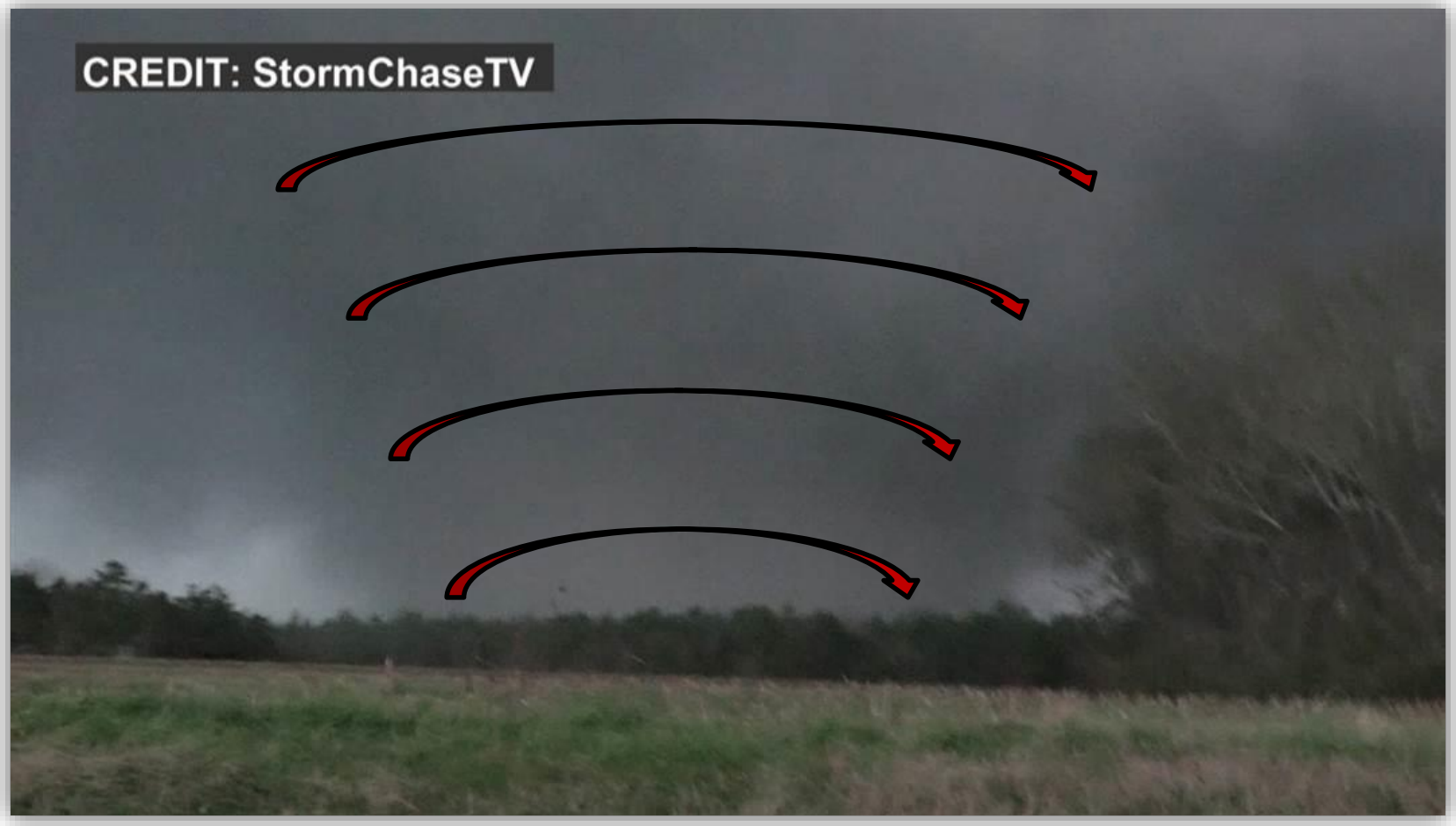

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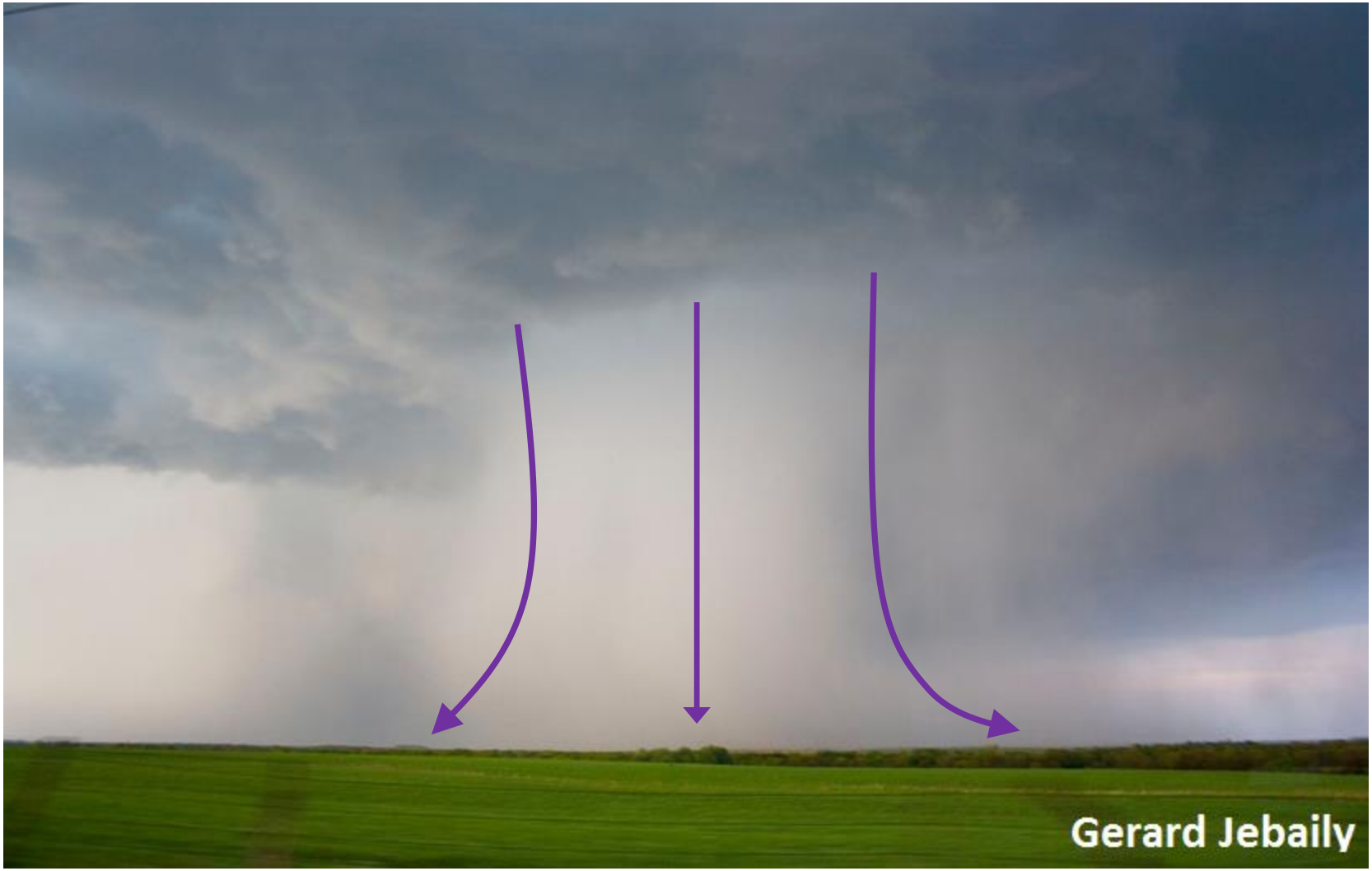

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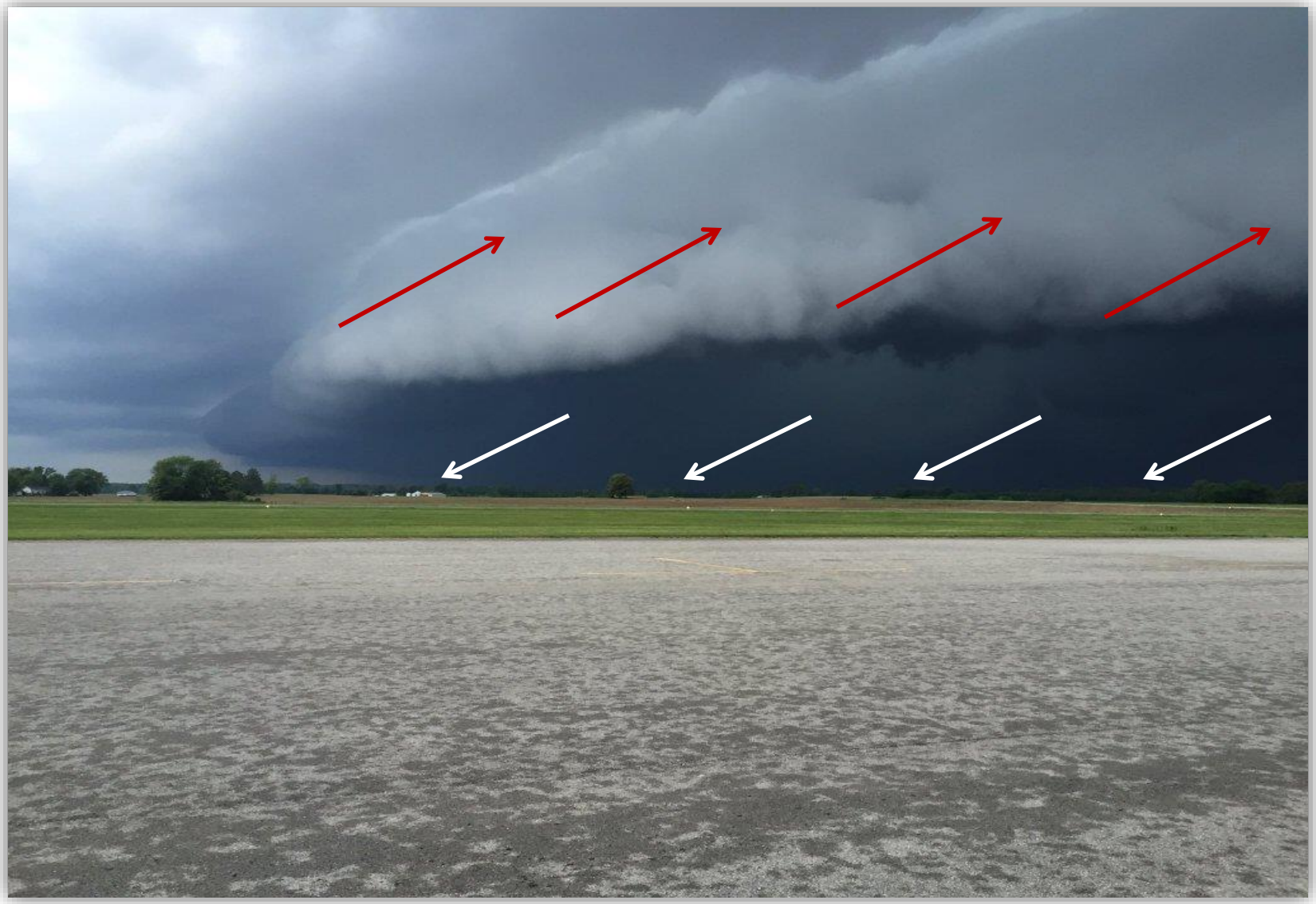

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Final Key Reminders

- **Know your weather terms:**
  - **Wall cloud:** a low-hanging 'blocky' cloud under the storm's updraft. Some wall clouds rotate and others do not. If rotating, watch for possible development of a funnel cloud and tornado.
  - **Tail cloud:** A low-hanging cloud that angles/feeds into the wall cloud. They are not dangerous, though they may form low to the ground.
  - **Scud clouds:** fragments of clouds hanging beneath the storm's base. They may be rising into the storm, but do not rotate and are harmless. They may collect to form a wall cloud if under the updraft, so keep watch.
  - **Funnel cloud:** a rotating, funnel-shaped cloud descending from the base of a thunderstorm.
  - **Tornado:** a violently rotating column of air in contact with the ground.
  - **Shelf cloud:** a low, horizontal cloud associated with a storm's cold outflow. You may see turbulent motions along the shelf cloud, but do not mistake this for something tornadic. Straight-line winds are the threat.

When you spot these, are they located in the correct part of the storm? Be sure before you report!

Final Key Reminders

- Know severe thunderstorm criteria
  - Winds of 58+ MPH; and/or
  - Hail 1 inch, or more, in diameter

  *A tornado also makes a storm severe, but triggers a Tornado Warning
- **Stay calm and be safe**
- **Pass along your reports to the NWS**
  - **Even if not severe; <1” hail, funnel cloud, wall cloud, etc.**
- **Do not exaggerate your report**

Reporting Options Recap

- Call the NWS office: 205-664-3010, option 2
- Social media: Twitter, Facebook
- Our webpage: 'Submit a Storm Report' page
- Photos of what you're seeing are great, too!

  sr-dss.bmx@noaa.gov

  – Snapshot of a funnel, wall cloud, flooding, etc.

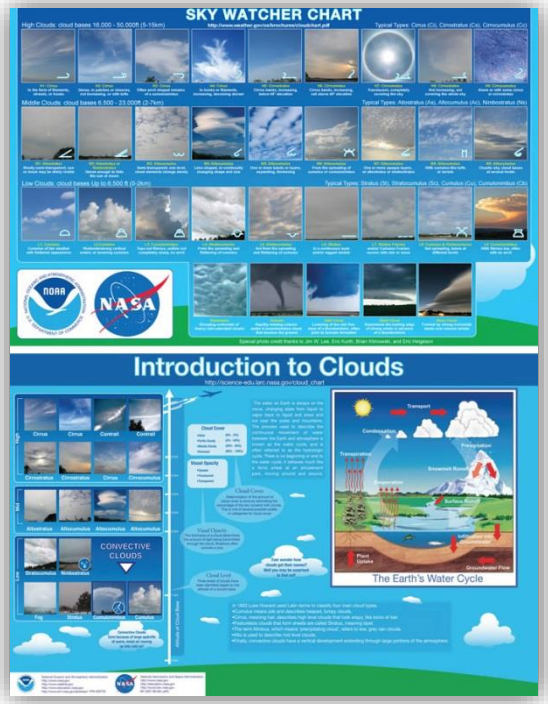
  – Hail, wind damage (trees, buildings, etc.)

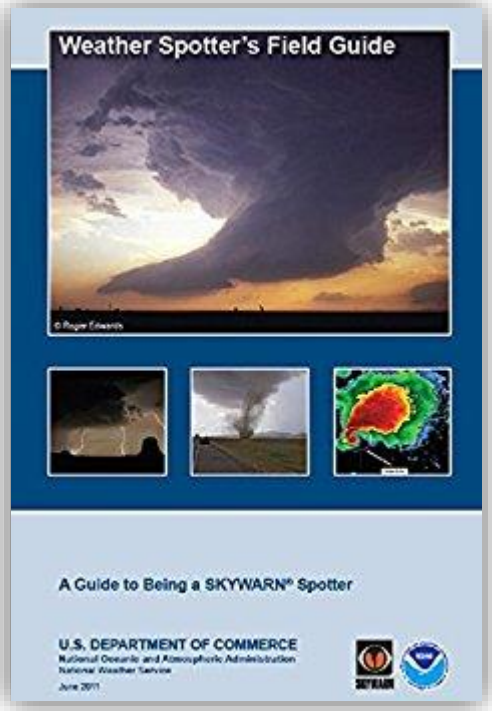
Don't use e-mail for urgent reports!

Additional Materials

Visit our Skywarn spotter page for useful links and information: weather.gov/bmx/skywarnschedule

- Spotter certificates
  http://www.weather.gov/bmx/spottertraining
- Spotter schedule
- Training materials
- Brochures and guides





SKYWARN Basic Spotter Training

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National Oceanic and Atmospheric Administration (NOAA)
National Weather Service (NWS) – Calera, AL

Questions, Suggestions, or Comments?
Gerald.Satterwhite@noaa.gov

We thank you for your participation!
Keep your eye in the sky!